# POWER

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ELY C. HUTCHINSON, *Editor*

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# Haste and Repent

O speed! what waste has been committed in thy name! I venture to say there is hardly an engineer of mature experience who has not deplored the incomplete thinking and consequent waste which have gone into some of the developments in his charge.

Of course, there are always reasons for rushing jobs through and at the time they have seemed logical enough. But were they? Here is a case in point.

A large hydro development was to be built. Following the usual procedure, plans were prepared for the dam and appurtenant structures and all was ready for bids when legal difficulties intervened to force a delay. Now in legal matters time seemingly becomes as nothing. So it happened that two years of enforced calm ensued in the construction division. The engineers took advantage of this to work out several alternative schemes for the development.

The result was a structure embodying all the features of the first plan plus an added provision for future power plant extension, at an estimated saving of $600,000. Furthermore, the contract was let at a price $335,000 lower than the estimate, or almost $1,000,000 lower than the original figure! Can money be better earned than by saving it that way?

Now there is a lesson in this. Any number of engineering executives are aware that their companies are going to need more power capacity when business gets to going again. They also know that the time is not far away. May they use the present opportunity for the rational development of plans, unhampered by the pressure of immediate need. May they not fail to realize that it takes two or three years to get into production after contracts are placed. The far-seeing will have the most economical installations—ready!

# EDITORIALS

## King Coal Needs a Nurse

The coal industry has been in an unsatisfactory condition for several years. In fact, it is probably one of the few industries that has successfully diagnosed its own troubles and not taken all steps to correct them. There are, of course, exceptions, but by and large there is continuing evidence that although the industry believes itself fully prepared and girded for the competitive fray it has, in fact, been left behind by its arch competitors, natural gas and fuel oil.

The remarkable strides that natural gas has made toward public favor in the past three years or so only serve to throw coal, as a power fuel, further into the shadow. The latest example of this was discussed in a paper presented at the Midwest Bituminous Coal Conference, held at Purdue University the middle of last month. It reviewed the introduction of natural gas into Rochester, Minn., a territory hitherto immune and considered safely in the column of the confirmed coal consumer.

Ever since it was known that the natural gas would be available in Rochester as a power fuel, and in fact long before, one wonders why the coal people were not more active in their own interest. It is hard to decide whether the seeming somnolence of the coal interests, as instanced by the Rochester case, is because of a cocksure confidence and abounding faith in some antiquated economic belief or is a result of simple ignorance of present-day marketing.

Perhaps it is neither, but an apathetic willingness to continue as "door mat" just because of having been so thoroughly under foot in the past. If the coal people agree with the last premise, enough has been said. If they take exception to it, let us hope the reaction will be sufficiently violent to awaken them to the necessity for protecting their own interests.

## Dollar-Conscious Engineers

Power is a fabric of heat units, kilowatts and dollars. If any one of these three factors is withdrawn from the consideration of a power problem what remains is as meaningless as a strip of cloth from which the threads of warp or weft have been removed.

Many economic mistakes have resulted from attempts to consider these factors independently. To such errors specialists are particularly liable. The engineer, for example, at times restricts his outlook to that of a "B.t.u. = kilowatt" specialist, and forgets that he must have more than a nodding acquaintanceship with the dollar.

How often, on the other hand, does the "money-wise" business man or industrial executive throw away the dollars he seeks to hold because he fails to understand that both heat units and kilowatts enter into the economic equation of power.

Economic forces will cause power decisions to gravitate more and more into the hands of men who make them intelligently.

## Showdown on Hotel Estimates

Operating records of power service find frequent publication in the technical press and are among the most valuable aids to the purchasing engineer. Somewhat less frequently published, and somewhat less valuable, are performance predictions made in advance of actual operation. It rarely happens that preliminary estimates are published simultaneously with actual accomplishments. The reason, undoubtedly, is that the discrepancies between theory and practice are thus made too glaringly apparent.

The engineering millenium would be hastened if more designers and operators were willing to lay all their cards on the table—to do, in short, just what Warren Lewis, chief engineer of the Hotel New Yorker, has done in the leading article of this issue. There, frankly and without equivocation, he compares the results of a year's operation with advance estimates made by the designing engineers, by the utility company which figured on purchased current and by members of *Power's* editorial staff.

This article, and another which will follow it shortly, gives the estimates and actual figures on boiler performance, low-pressure steam demand, electrical load and the balance between exhaust steam and low-pressure-steam demand. This comparison of actualities with estimates will interest every engineer who finds a sportsman's satisfaction in observing a "guessing contest" that is right down his own alley.

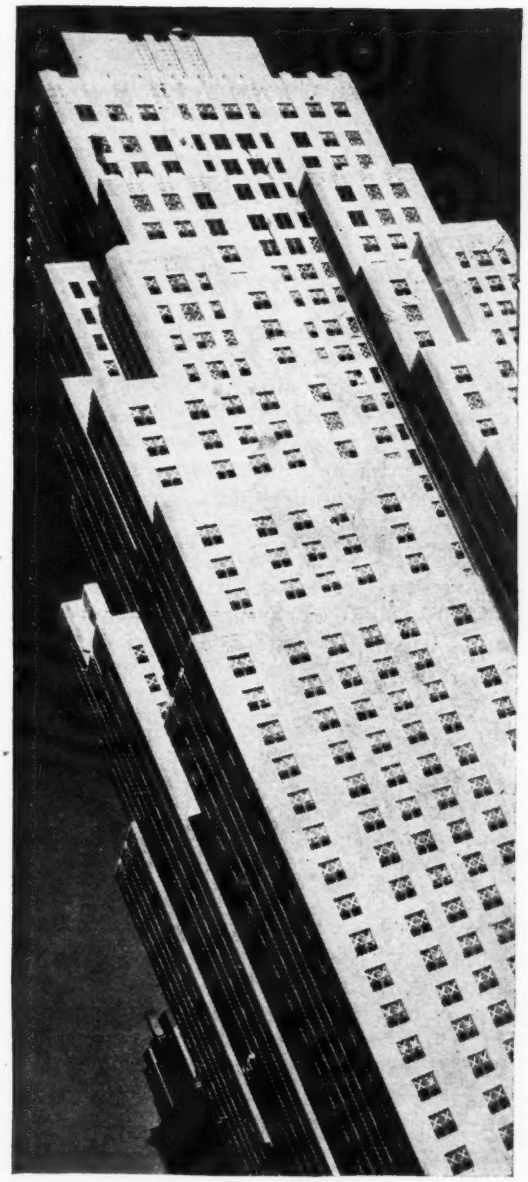
When Lindbergh hit Europe within five miles of the intended point he admitted that such accuracy must be credited to luck. To have hit within 25 miles would have been navigation. The same, perhaps, should be said of certain New Yorker estimates which fall within 5 or 6 per cent of the actualities. The New Yorker Hotel differs radically from hotels previously constructed and thereby introduced factors hard to evaluate on the basis of the very meager data available on the operation of other hotels.

Mr. Lewis's article will interest many and will serve to emphasize the crying need for more and better data on the power service demands of hotels and similar institutions.

▼

## POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason



**Three guesses**

are generally allowed. The New Yorker made public that many estimates of steam and electrical load before operation. Now comes the reckoning — the actual results compared with the predictions made by the "Engineers," the "Utility" and "Power"

# DESIGN VS. OPERATION AT THE HOTEL NEW YORKER

By WARREN D. LEWIS
*Chief Engineer*
*Hotel New Yorker*

## PART I—LOW-PRESSURE STEAM

THE Hotel New Yorker has been open to the public since Jan. 2, 1930, and the power plant has been in service a few months longer. *Power* devoted the entire issue of Nov. 26, 1929, to a description of the mechanical and electrical equipment installed, as well as to its design and the results to be expected in operation.

### THREE GROUPS MADE ESTIMATES

It was thought that a comparison at this time of the actual operating results with the design figures would prove interesting, especially as there are from one to three preliminary estimates, in many cases, to check against. With this idea, the operating results of the year 1931 will be compared with the article by P. W. Swain, associate editor of *Power*, pages 826 and 827, and the article by L. H. Morrison, associate editor of *Power*, pages 830, 831 and 832. It will thus be possible to check the actualities against the opinions of the *Power* editors, the engineers of the New York Edison Company, and the engineers responsible for the general design and employed by the owners. For brevity the results will be labeled as follows:

1. *"Actual"*—Results obtained during the year 1931, unless otherwise stated.
2. *"Power"* — Calculations or opinions advanced by Messrs. Swain and Morrison of the *Power* staff.
3. *"Utility"*—Figures and estimates submitted by the New York Edison Company as quoted in *Power*.
4. *"Engineers"*—Estimates of the hotel's designing engineers working with the engineers of the Skinner Engine Company.

### TWO BOILERS ON—TWO OFF

It might be well at this time to mention briefly a few details regarding our steam-producing equipment. This consists of four 6,500-sq.ft. cross-drum water-tube boilers equipped with superheaters and fired with unit pulverizers. Two boiler units are operated at one time.

Of the other two, one is held as a spare and the other is available for repairs. The New Yorker accounting system and all records are kept on a yearly calendar consisting of thirteen periods of four weeks each. Boilers are operated on a basis of one boiler put on and one taken off at the beginning and middle of each period. This leaves any particular boiler in service four weeks and out of service the four following weeks. This schedule has proved very satisfactory from a maintenance standpoint, as nothing is allowed to get in bad shape before it is repaired.

The large reserve boiler capacity was installed because of the original plan of the builders to extend the service from the power plant to the rest of the city block. Economic reasons have prevented the carrying out of the plan so far.

While two boilers are carried on the line at all times, only one is needed at night, when the laundry shuts down. The average daily coal consumption is 40 gross tons, or about 45 net tons. On the basis of an evaporation of 10 lb. of water per pound of coal, this would be an hourly evaporation of about 37,000 lb. for the two boilers, and is slightly less than rating. However, with one boiler banked at night for several hours, the boilers operate very nearly at 150 per cent of rating most of the time. This has proved to be the best operating point.

Our problem, as pointed out by Mr. Swain, starts with the estimated requirements of low pressure or "service" steam for heating, hot water, laundry, kitchen, etc., as distinguished from "power" steam required for operating the engine-driven electric generating units, the exhaust of which is used to supply some of the low-pressure steam requirements.

## VOLUME BASIS VERSUS ROOM BASIS

For design purposes low-pressure steam requirements were estimated on the actual consumption of other hotels, either on a basis of volume or the number of rooms. That the volume basis is the most logical and safest for estimating purposes may be judged by comparing the volume and number of rooms of several New York hotels, as shown in Table I.

TABLE I — COMPARISON OF ROOMS AND VOLUME

| | Rooms | Volume, Cu.Ft. | Cu.Ft. per Room |
|---|---|---|---|
| New Yorker | 2,500 | 12,400,000 | 4,960 |
| Hotel No. 1 | 2,200 | 18,778,000 | 8,535 |
| Hotel No. 2 | 2,000 | 12,678,000 | 6,339 |
| Hotel No. 3 | 1,100 | 8,300,000 | 7,545 |
| Hotel No. 4 | 1,000 | 12,000,000 | 12,000 |

The great difference in "cubic feet per room" for various hotels listed has two causes: First, the older hotels have larger guest rooms, and second, the public rooms, ball rooms, etc., are in some cases a greater proportion of the total volume as exemplified by Hotel No. 4.

"Low-pressure" steam demand includes 100-lb. pressure steam for the laundry requirements as well as the 40-lb. pressure steam for heating kitchen equipment.

The actual low-pressure steam requirements are obtained from the readings of the steam-flow meter, which measures the steam of 100 lb. pressure used by the laundry plus the steam at 40-lb. pressure used by the kitchen. The latter is likewise measured by a flow meter.

To this is added the low-pressure steam used in heating the building, as well as that used in heating hot water for the building, laundry, kitchen, etc. After passing through the hot-water heaters and the building system the condensed steam is measured by a condensate meter. Naturally, any high-pressure make-up steam added to the heating system is measured by the condensate meter, although no provision is made to measure the actual amount of live steam used in this manner.

TABLE II — YEARLY LOW-PRESSURE STEAM REQUIREMENTS

| | Steam in Pounds | Lb. per Cu.Ft. Building-Volume | Per Cent Error |
|---|---|---|---|
| 1. *Actual* | 186,735,000 | 15.1 | ..... |
| 2. *Power* | 198,000,000 | 16.0 | 6.0 high |
| 3. *Utility* | 170,850,000 | 13.8 | 8.6 low |
| 4. *Engineers* | 160,608,000 | 13.0 | 13.9 low |

In Table II, the *Power* estimate for low-pressure steam is based on a study of other New York hotels. This showed "an average of 11.6 lb. of low pressure steam consumed per year per cubic foot and 122,000 lb. per room." Using this we get "144,000,000 lb. on the contents basis and 305,000,000 lb. on the room basis." With such a wide discrepancy a weighted average was struck between the two, giving twice the preference to the volume basis as follows:

$$\frac{(2 \times 144{,}000{,}000) + 305{,}000{,}000}{3} = 198{,}000{,}000 \text{ lb.}$$

The *Utility*, from experience with other hotels, used a figure of 13,778,000 lb. of low-pressure steam per million cubic feet of building volume, and based on the volume of the New Yorker (12,400,000 cu.ft.) the low-pressure steam requirements would be 170,850,000 pounds.

As shown in Table II, the anticipated low-pressure steam demands were closely estimated. The coal requirements are based on various evaporation factors as shown in Table III, while Table IV gives the yearly coal requirements to produce the low-pressure steam.

While the *Utility* in its estimate of an evaporation of 8.5 lb. water per pound of coal is too conservative in the total coal required for low-pressure steam, it is much closer to the actual requirements than the *Engineers*.

The figures given in Table IV are obtained in various ways. *Actual* is the tons of coal required to evaporate 186,735,000 lb. of water with the average evaporation for the year of 1931 of 9.96 lb. water per pound of coal.

*Power* is based on an estimated yearly low-pressure steam requirement of 198,000,000 lb. by Mr. Swain, and an evaporation of 10 lb. water per pound of coal by Mr. Morrison.

*Utility* comes from the estimated requirements of 170,850,000 lb., with an evaporation of 8.5 lb. water per pound of coal, as given in Table II. The actual *Utility* estimate was subdivided and based on experience with other New York hotels where the evaporation is only 6.5 lb. water per pound of coal. The estimated heating requirements, with an improved evaporation of 8.5 lb.,

TABLE III — EVAPORATION — POUNDS OF WATER PER POUND OF COAL

| | Evaporation | Per Cent Error |
|---|---|---|
| 1. *Actual* | 9.96 | ..... |
| 2. *Power* | 10.0 | 0.4 high |
| 3. *Utility* | 8.5 | 14.7 low |
| 4. *Engineers* | 10.5 | 5.4 high |

TABLE IV — COAL REQUIRED FOR LOW-PRESSURE STEAM PER YEAR

| | Tons | Per Cent Error |
|---|---|---|
| 1. *Actual* | 9,374 | ..... |
| 2. *Power* | 9,900 | 5.6 high |
| 3. *Utility* | 10,050 | 7.2 high |
| 4. *Engineers* | 7,648 | 18.4 low |

were 3,500 tons of coal. On this evaporation basis for hot water, at the rate of two tons of coal per bathroom per year, the *Utility* estimated 3,840 tons for this service. The estimated laundry and kitchen requirements were 2,710 tons, giving total low-pressure steam consumption of equivalent to 10,050 tons of coal.

The *Engineers* estimate of heating requirements for the various months of the heating season totals 3,340 tons. The coal required for hot water is based on assumed quantities for the kitchen and laundry, as well as 30 gal. per day per guest room, and gives a total of 4,308 tons. This is also assumed to cover the higher pressure steam required by both the laundry and kitchen. How near to the actual 1931 requirements the estimates come is shown in Table IV.

One of the subjects considered in power plant design is heat balance, or, more properly speaking in this case at least, "steam balance." Here the results were not as expected, as will be shown.

## ESTIMATES OF AVAILABLE EXHAUST

Calculations are based on an engine steam rate of 28 lb. per kilowatt-hour. Low-pressure steam requirements were estimated by *Power*, Table II, as 198,000,000 lb. yearly. It also estimated 5.8 per cent of this as required for July, which would give 11,484,000 lb., or 370,000 lb. per July day. *Power* also estimated the electrical load as 644,800 kw.-hr. for July, which gives an average daily electrical load of 20,800 kilowatt-hours.

On the basis of steam requirements of 28 lb. per kilowatt-hour, the following is obtained:

*POWER* ESTIMATE FOR HEAT BALANCE

| | | |
|---|---|---|
| (1) | 20,800 kw. × 28 lb. | 582,400 lb. exhaust |
| (2) | Estimated requirements | 370,000 lb. |
| (3) | Excess exhaust | 212,400 lb. |

An amount not less than the excess exhaust must necessarily be wasted to the atmosphere. Estimated hourly curves for low-pressure demand and available exhaust were prepared by *Power*. The available exhaust line was above the demand line at all hours of the day, indicating that the steam wasted would equal 212,400 lb., the daily excess of exhaust over demand.

Now on the basis of operating the diesel at full load of 350 kw. for 24 hr. we would generate

$$350 \text{ kw.} \times 24 \text{ hr.} = 8{,}400 \text{ kw.-hr. daily.}$$

and the reduction in exhaust steam if the diesel were operated would be (4) $8{,}400 \times 24$ lb. $= 201{,}600$, it being assumed that diesel waste heat equivalent to 4 lb. of steam per kilowatt-hour is recovered.

Comparing (4) with (3), we find

| | | |
|---|---|---|
| (3) | 212,400 lb. | |
| (4) | 201,600 lb. | |
| (5) | 10,800 lb. | |

excess of daily exhaust over daily demand, according to the *Power* estimate. With diesel, operating, however, the *Power* curves for demand and exhaust crossed, indicating an actual deficit of exhaust steam for part of the day, which in turn indicated an actual loss for the day of 48,000 pounds.

## THE ACTUAL HEAT BALANCE

The actual low-pressure steam requirements on a July day are lower than the estimate and will be used with the actual electrical output of the power plant, which is 874,830 kw.-hr. for July or a daily average of 28,220 kw.-hr.

The actual low-pressure steam balance is then something like this:

| | | |
|---|---|---|
| (6) | 28,220 kw.-hr. × 28 lb. | 790,160 lb. |
| (7) | Actual low-pressure requirements | 285,000 lb. |
| (8) | Excess | 505,160 lb. to atmosphere |

Operating the diesel 24 hr. per day would eliminate 201,600 lb. of exhaust.

Again comparing (4) with (8).

| | | |
|---|---|---|
| (8) | 505,160 lb. | |
| (4) | 201,600 lb. | |
| (9) | 303,560 lb. excess exhaust to atmosphere | |

This would mean 12,650 lb. of steam exhausted hourly to the atmosphere, which shows how an increase of over 35 per cent in the estimated electrical requirement of the hotel "unbalanced the heat balance." There were certain practical reasons why it was uneconomical to operate the diesel. These will be explained in a later article.

## MORE DATA NEEDED ON HOTEL DESIGN

It would be possible to carry the comparisons further, but I trust that the above will be sufficient to show the general results obtained. Looking at the subject of anticipating steam requirements in any building, it would seem to be a simple matter if satisfactory records were kept and a unit basis worked out for design purposes. Steam heating design is a practical art, so that the heating load of any building (knowing the general construction, volume, location, etc.) should be known within close limits before it is actually built. To endeavor to work out the heating load in a hotel on the basis of the number of rooms is rather a far-fetched idea unless all hotels are of similar type and proportions. The steam requirements for laundry, kitchen and hot-water purposes would seem to be also a matter for designers in this class of equipment to furnish data upon.

It would certainly seem that more research and statistics are necessary, so that reliable operating results may be calculated before construction.

[*A second and concluding article, May 17, will compare the actual New Yorker electrical load with the various advance estimates*—EDITOR.]

# Gantry Cranes for Hydro-Electric Plants

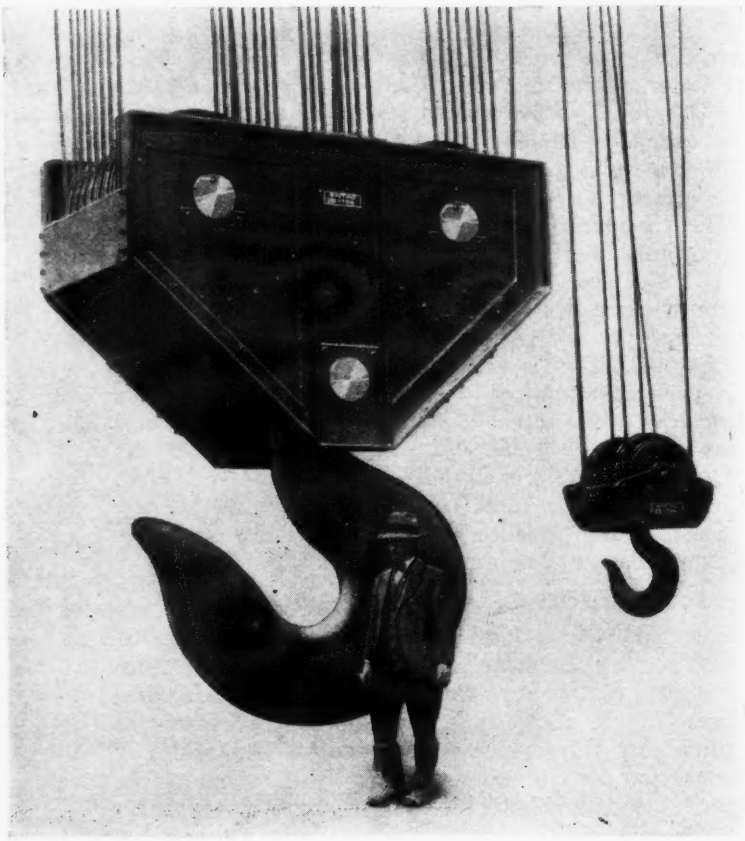


**Fig. 1—Main hook of the 350-ton gantry crane for Ariel plant. The hook is a single forging weighing 10 tons**

MANY modern hydro-electric plants require large gantry cranes in their construction and operation. These are used for lifting and lowering flood and regulating gates on dams, head gates and stoplogs at power houses, and others are installed for handling the equipment of outdoor and semi-outdoor type of plants. In this article, the data and photographs for which were supplied by the Whiting Corporation, attention is called to several installations of both types.

The largest gantry crane for power house service is the one installed at the Ariel hydro-electric plant of the Inland Power & Light Company on the Lewis River at Ariel, Wash. At present this plant, Fig. 3, contains a 45,000-kw. generator direct connected to a 61,600-hp. vertical turbine operating under a normal head of 185 ft. The power house is built for two units and foundations and penstocks are set for two more.

In this project gantry cranes are used for handling the gates from the top of the dam, Fig. 2, and for serving the power house, Fig. 3. The 150-ton capacity crane on top of the dam for handling the gates has a 17-ft. span and a lift of 192 ft. This crane has equalizing trucks to permit travel around the curve of the dam. The power-house gantry crane, Fig. 3, is of 350-ton capacity from a single hook. It has a span of 67 ft., an 80-ft. lift, and is the largest-capacity crane of its type ever built for this kind of service. Two drums were necessary to secure the unusual height of lift required. The main hook, Fig. 1, is used to lift the rotor, runner and shaft as a unit, having a total weight of 350 tons. This hook is a single 10-ton forging. The complete block with hook is 10 ft. high and accommodates 32 parts of $1\frac{1}{4}$-in. cable. The crane has a lifting speed of 3 ft. per minute with a 255-ton load. There is also an auxiliary hook of 25 tons capacity, to handle the smaller parts. The trolley travels the full length of the bridge and out on a cantilever extension at one end for lifting transformers.

The Osage development on the Osage River, near Bagnell, Mo., built by Stone & Webster Engineering Corporation, consists of a concrete dam and a power station integral with and forming a part of the dam, having a combined length of 2,543 ft. and a maximum height above bedrock of 148 ft. The dam proper has an overflow section totalling 1,512 ft. in length and a spillway section 520 ft. long. The spillway is surmounted by by 12 tainter gates 23 ft. high x 34 ft. wide.

Six units of 33,500 hp. each, operating under a 90-ft. head and direct-connected to a 21,500-kw. generating unit and two 2,100 kw. generating service units, comprise the initial installation. Provisions are made for the installation of two additional main units which will make the station's ultimate capacity 172,000 kilowatts.

A feature of the power house, Fig. 4, is absence of a superstructure. Each generating unit is protected by a metal hood. The 150-ton one-leg gantry crane serving the generating units is shown handling a rotor. The crane placed the generating machinery during construction and will handle repairs or future additions. This crane also has a cantilever extension, with a special trolley and lifting attachment for handling draft-tube stoplogs. The two main trolleys with twin hooks and special lifting beam are arranged to operate in unison for handling the heavy turbine parts. There are also two gantry cranes on the dam for handling the gates. Each is of 70 tons capacity and 19-ft. span. The hoisting unit is completely housed by a steel-top section, glassed in.

The Rock Island Development of the Puget Sound Power & Light Company at Rock Island, Wash., another Stone & Webster project, is the first major water-power development on the Columbia River. It is planned for a

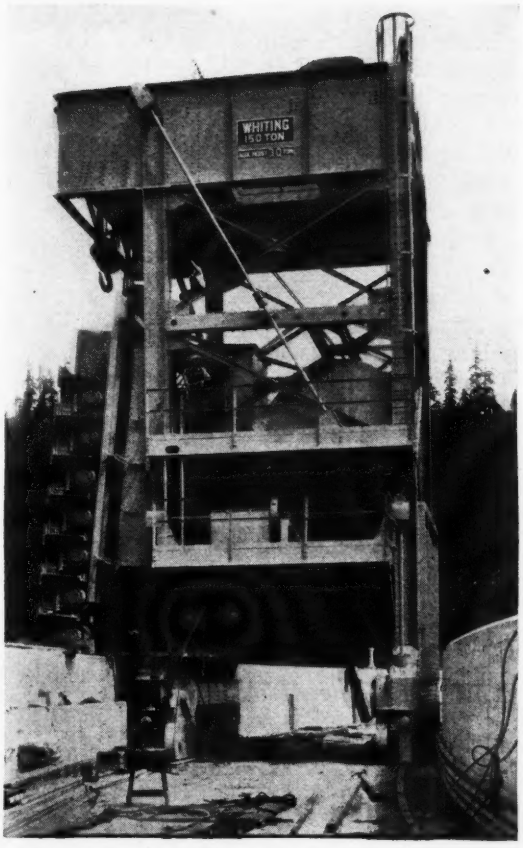



Fig. 2—The 150 tons capacity crane on top of the Ariel dam for handling the gates has a 17-ft. span and a lift of 192 ft., requiring a hoisting drum 8 ft. in diameter by 16 ft. long. This crane has equalizing trucks to permit travel around the curve of the dam

Fig. 3—Ariel power house gantry crane is of 350-tons capacity on a single hook. It has a span of 67 ft. and an 80-ft. lift. The main hook is used to lift the generator rotor and waterwheel runner as a unit, having a total weight, with their shaft, of 350 tons.

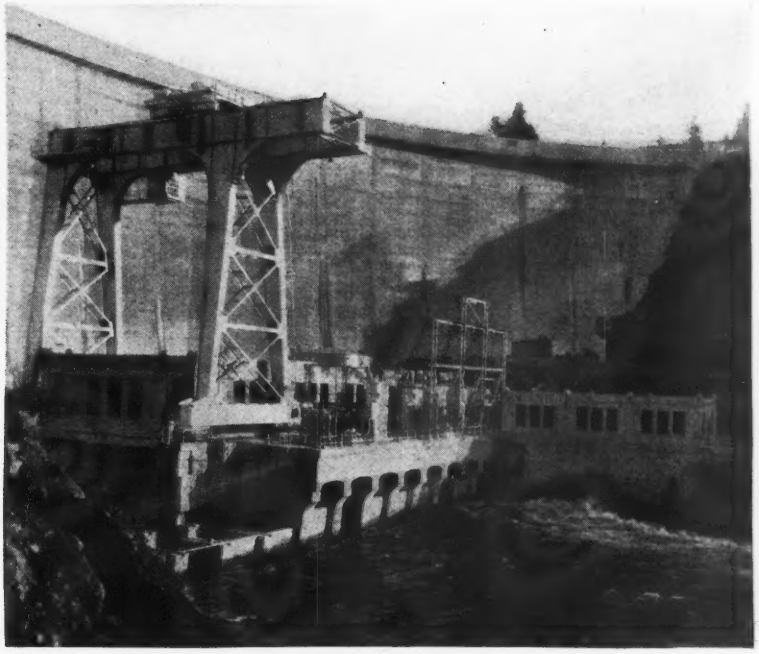
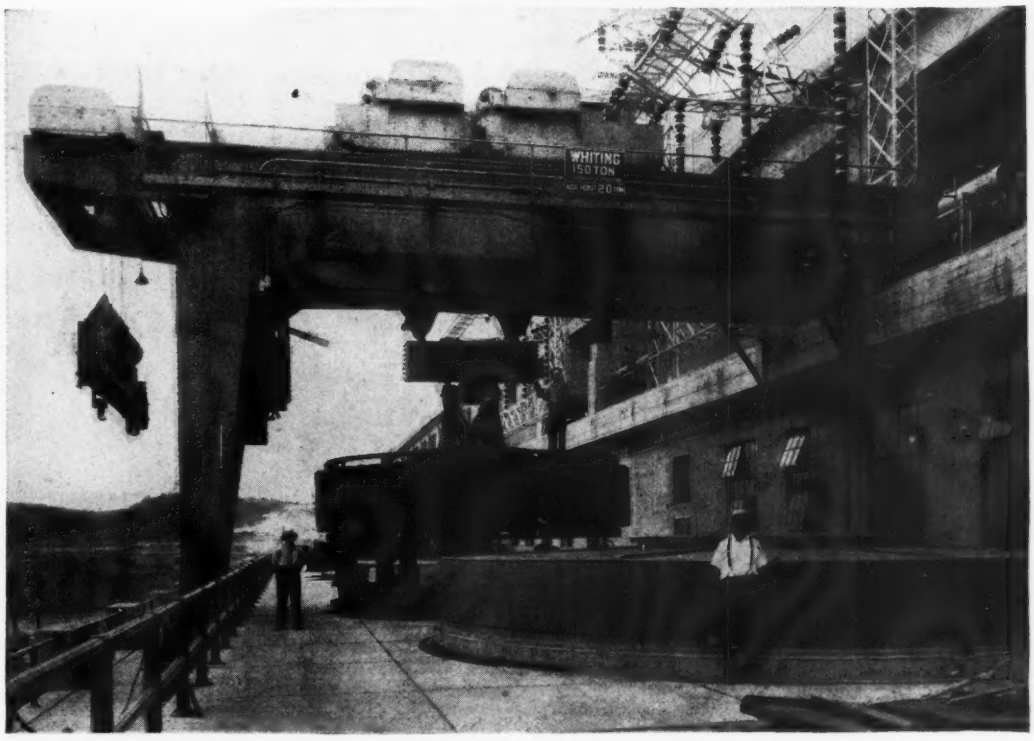


Fig. 4—The 150-ton, one-leg gantry crane serving the generating units in the Osage power house is shown handling a generator rotor. This crane also has a cantilever extension with a special trolley and lifting attachment for handling draft-tube stoplogs



maximum capacity of ten 15,000-kw. generating units, with provisions for possible addition of two more if required, but the initial capacity will be four units. The gate openings are of two depths, to conform to the elevation of the stream bed. The larger openings have a height of 41 ft. from sill to ultimate crest, and the smaller ones are 18 ft. 6 in. high.

Two gantry cranes are used, one an 80-ton four-motor type of 28-ft. span for lifting the gates, and the other a 20-ton two-motor type with a 5-ft. span for raising, lowering and transporting draft-tube stoplogs. Fig. 5 is a close-up of the 80-ton crane installing the lower section of a headgate, which with its upper section will close an intake opening 15 ft. 4 in. wide and 27 ft. 11 in. high. This crane is also used to operate crest gates on the dam. It is unique in that a swivel truck construction permits travel around the curve connecting the two straight portions of the dam. Mounted on top of the gantry bridge is a transfer bridge moving at right angles to the main structure, and on top of the transfer bridge are two trolleys arranged so that the spacing between hooks can be adjusted to suit different sizes of gates.

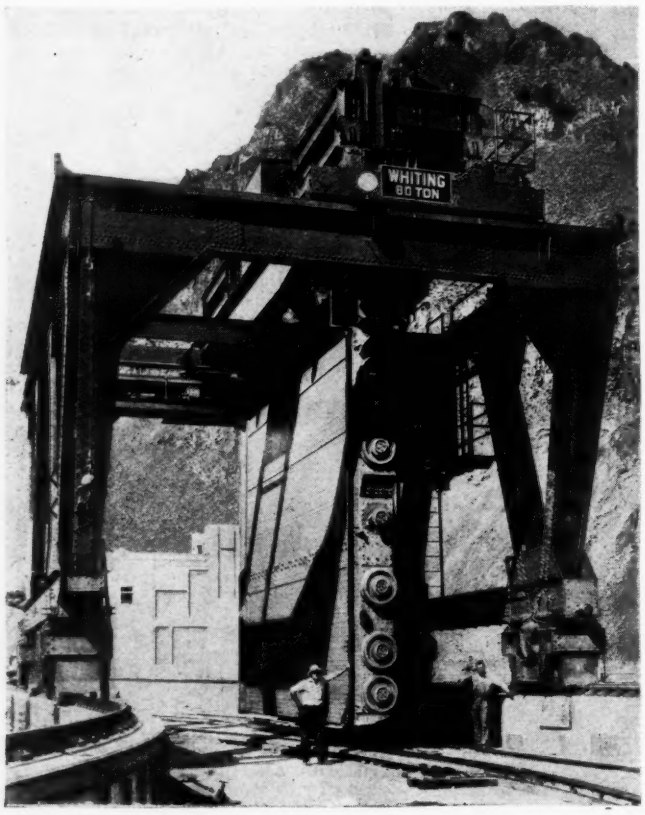



**Fig. 5—The 80-ton gantry crane on the dam of the Rock Island project, for lifting the gates. The crane is shown installing the lower section of a head gate. It is equipped with a swivel truck construction to permit travel around the curve connecting the two straight sections of the dam. Mounted on top of the gantry bridge is a transfer bridge moving at right angles to the main structure, and on top of the transfer bridge are two trolleys arranged so that the spacing between the hooks can be adjusted**

The 20-ton crane is equipped with a special lifting beam for handling the stoplogs, arranged to automatically engage or deposit the stoplogs under water, and provided with operating ropes to permit manual control of the automatic devices while the beam is immersed. A special feature of this crane is the mounting of all electrical equipment, together with the central gear unit, in an individual housing on top of the gantry structure. The housing is readily detachable from the gantry framing and fitted with eyebolts for lifting out of reach of possible flood water. This crane has a hoisting speed of 15 ft. per minute and travel speed of 200 ft. per minute.

The Calderwood power plant of the Aluminum Company of America is the third and most recently completed power project of that company in its hydro-electric development of the Little Tennessee River system. Calderwood dam consists of a thin-section concrete arch 230 ft. high, and is the first dam of this type on which actual deflection measurements have been made. The power house is designed for three 56,000-hp. reaction turbines operating under a head of 213 ft. Two of these units have been installed and are in service.

Mechanical equipment on this dam, including two gantry cranes, Fig. 6, permits the operation of the entire flood gate and outlet works by one man. The cranes are principally of steel-plate construction. All of the machinery is located on the upper deck for ready inspection and maintenance. Each crane has a 35-ton hoist for the main operation of raising and lowering gates, and two 3-ton auxiliary hoists for handling the roller trains. The trucks are aranged for traveling on a circular runway.

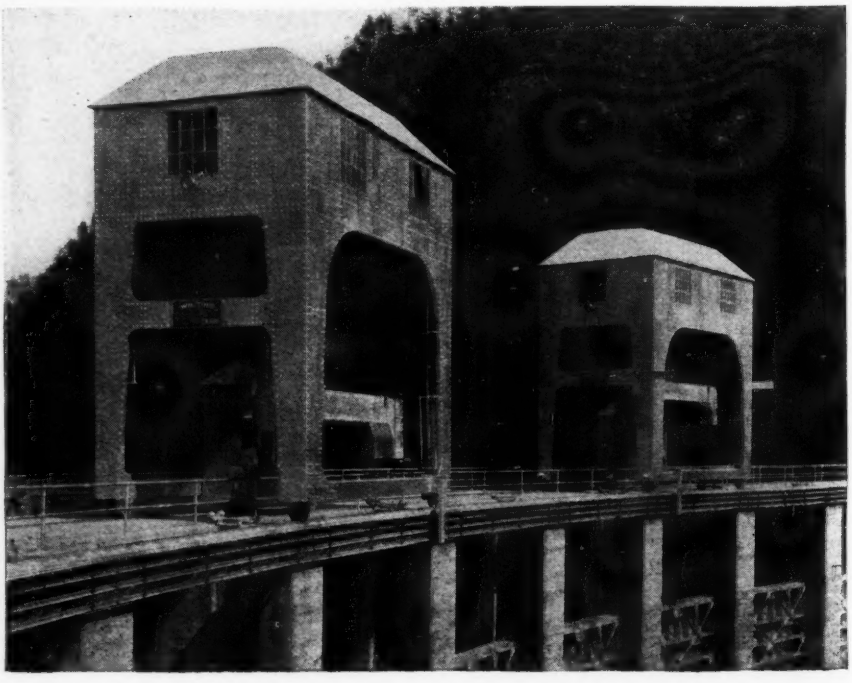


**Fig. 6—Two gantry cranes on the Calderwood dam permit the operation of the entire flood gate and outlet works by one man. Each crane has a 35-ton hoist for the main operation of raising and lowering the gates, and two 3-ton auxiliary hoists for handling the roller trains**

# Causes and Control of SLAG FORMATION

By JAMES L. CORCORAN
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THE FUSION of ash, which is a preliminary step to slag formation, depends on the temperature to which the ash is subjected and on the composition of the ash. Ash may be roughly divided into three classes with regard to softening temperature, namely, refractory ash, softening above 2,600 deg. F.; medium fusion ash, softening between 2,200 and 2,600 deg. F., and easily fusible ash, softening below 2,200 deg. F. Of these three classes, the last two are the cause of practically all slagging problems arising in the burning of coal.

**If the burning of coal consisted merely of combustion of the carbon and volatile matter, and disposal of the residue in the form in which it enters the furnace, the problem of slag formation would be relatively simple. However, the changes that take place in the ash during the burning of the combustible are the source of many operating troubles. This article discusses the theory of slag formation, the melting points of ash as determined by its constituents, slagging in stoker and pulverized-coal furnaces, and the usual methods of coping with the problem**

The ordinary impurities in coal consist largely of compounds of silica, alumina, iron, lime, and smaller quantities of magnesia, titanium, alkali, sulphur and phosphorus compounds. However, these compounds are probably not present in the forms in which they are found in the ash after combustion. The substances may exist as particles dispersed throughout the coal, in sizes ranging from the submicroscopic to several millimeters, or as segregated planes or aggregations of ash-forming substances. In order to understand the formation of slag, it is well to attempt to trace the coal and ash through the combustion processes.

The liberation of the volatile matter in the coal probably has little effect on the ash, although there will be a release of SO from some of the sulphates, and liberation of half the sulphur in $FeS_2$ and part of the sulphur combined with carbon. The increase in temperature as ignition of the remaining carbon takes place gives rise to the first important ash reactions. Iron sulphide is oxidized first to form $FeSO_4$, and then $SO_2$, $SO_3$, FeO, $Fe_2O_3$ and $Fe_3O_4$, with the possibility of the formation of various intermediate compounds. The organic iron compounds are converted to FeO and $Fe_2O_3$.

It is probable that no reactions between the constituents of the ash take place before the end of the combustion process. It seems, therefore, that ash up to the point of complete burning of the combustible to which it is attached remains in its original composition or as compounds formed by decomposition and oxidation. From a physical standpoint, the ash particles may retain their shape, as in the case of inert constituents, or may be in the form of a cluster of particles of newly formed compounds.

At this point the reactions begin which form clinker or slag. In stoker firing this point is reached only after the coal has traveled through the entire grate, a process which requires some time; in pulverized-coal firing, the entire reaction up to this point takes place while the particle is traveling in the gas.

The reactions that an ash particle undergoes after the process has reached the above-mentioned point depend chiefly on the temperature to which it is subjected, on its size and on its path through the furnace. If the coal is being burned on a stoker and the ash is firmly attached to a large piece of burning coal or other piece of ash on the fuel bed, it will probably remain there. If the temperature of the ash reaches the agglomeration point, the temperature at which the solid particles begin to adhere to one another, it will adhere to any other ash with which it comes in contact.

With rise in temperature to the point of incipient fusion, the ash adheres more and more tenaciously, and reactions begin to take place. Oxides agglomerate lower than silicates, but in general their melting points are higher. Thus the oxides adhere without reaction until they reach a silicate or sulphide in a pasty condition. Reaction then occurs as a base dissolving in a viscous acid, and the softening temperature may be lowered, so that the particle may be more fluid after reaction than before.

If the reactions between the ash constituents take place on a stoker bed, clinker is formed on the bed or side walls of the furnace when the ash cools from the fluid condition. If the particle has been carried from the bed by furnace gases, it will go through the slag-forming reactions if the furnace conditions are favorable.

A particle of ash from pulverized coal will undergo the reactions while floating through the combustion space after the carbon has been burned away. It can easily be seen that slag formation on boiler tubes and furnace walls depends more on temperature than on any other furnace condition. However, there are many possibili-

ties for the final disposition of ash floating in the combustion chamber. Two attached particles may reach the reaction temperature during their flight, and owing to the surface forces of the plastic state they will suddenly lose their shape and drop. Likewise, the temperature of the ash after combustion may be below agglomeration point, so that it is carried by the gas through the boiler and out the stack. Another possibility is that the ash may be heavy enough to drop as soon as combustion takes place and it loses the initial kinetic energy of its entrance into the furnace.

The fusing temperature of ash may be lowered considerably by reactions of different constituents, but the temperature at which it becomes fluid is not decreased in the same proportion. It may be well to consider at this point some of the factors influencing the temperature at which slag is formed from coal ash.

### Melting Points of Ash Constituents

The melting points of some of the typical constituents of coal ash are as follows: $SiO_2$ melts at about 2,940 deg. F.; MgO at about 5,100 deg. F.; pure alumina ($Al_2O_3$) at about 3,700 deg. F.; CaO at 4,650 deg. F.; and $Fe_2O_3$ begins to dissociate as temperature rises, into oxygen and a solid solution containing ferrous iron, which may be considered as a solid solution of $Fe_3O_4$ in $Fe_2O_3$. The melting point of $Fe_3O_4$ is about 2,870 deg. F.

The following is a table of ash analysis with the softening temperatures of the ash.

A comparison of the ash-fusion temperature with the constituents of the ash shows that there is a great difference between them, although as the $SiO_2$ content of the ash rises the fusing temperature approaches that of pure $SiO_2$. It is evident that ash has no single definite melting point, nor is the gradual softening and melting of the ash merely the successive melting of various ash constituents. Reactions involving the formation of new and more fusible compounds take place as the ash agglomerates and fuses, and the melting temperature of the newly formed compounds are influenced by solution in one another to a greater or less degree, with the new compounds having a eutectic or minimum melting point at a certain composition of the compound.

The question as to whether the furnace temperature is oxidizing or reducing also has an important effect on the fusing temperature of ash. In an oxidizing atmosphere, such that ferric oxide is formed from the iron compounds present, or in a strongly reducing atmosphere, such that iron is largely reduced to the metallic state, high softening temperatures of the ash may be expected. If the iron is reduced to the ferrous state, in which it unites readily with the silica present to form silicates, a ready-fusing compound can be expected. If metallic iron is formed, one of the most active fluxing constituents is removed and high fusing point results.

### Slag Formation in Stoker-Fired and Pulverized-Coal-Fired Furnaces

Slag formation in stoker-fired furnaces depends on a number of factors peculiar to the method of coal burning. While the temperature of formation of slag may be practically the same for identical coals, the conditions of formation may vary considerably. The reactions in the burning of coal on stokers take place in the fuel bed, hence most of the ash remains on the fuel bed and is dumped. Any ash that is carried from the grate may form slag, or may be discharged with the stack gases. The carrying of ash from the fuel bed depends on the nature of the ash and on the condition of the burning coal on the grate. Small particles of ash and combustible on the bed are easily swept into the combustion space by the furnace draft, and the condition may be seriously aggravated by holes in the fuel bed or a very thin fuel bed.

The fact that a particle of ash is floating in the combustion space does not necessarily mean that it will form slag. The question as to whether the particle will slag or not depends in general on the temperature of the furnace, the furnace atmosphere, the velocity of the gases and the path of the gases. Assuming that the ash on leaving the fuel bed has gone through the preliminary reactions described before, the temperature of the zones through which it passes determines whether it will attain fusion temperature before reaching the boiler tubes or furnace walls. If it has fused it will deposit as slag on striking a cooled surface; otherwise it will be carried away as fly ash.

The coal and ash particles in pulverized-coal-fired furnaces go through the combustion and slag-forming reactions while floating through the furnace. When the combustible to which the ash is attached has completely burned, the reactions begin to take place between the ash constituents. It is highly probable that the agglomeration point of the ash is reached during its passage through the combustion space; hence if two ash particles come in contact with each other they will adhere. Partial reactions may take place between the particles, lowering the fusing temperature and enhancing the possibility of adhesion of the ash to walls or tubes on contact.

Since all of the ash from pulverized coal is floating in the combustion chamber, the possibility of slag formation is increased considerably compared with the chance of slag forming in stoker-fired furnaces, provided furnace conditions are the same for both types of firing. It is apparent that slag accumulation is a much more serious problem with pulverized-coal firing than with stokers. However, with either method of firing, slag accumulation on boiler tubes and setting is an important factor in determining the capacity and operating cycle of the boiler.

### Effect of Slag Accumulation on Boiler and Setting

Slag on boiler tubes and furnace walls will usually fall under one of two conditions. Either it will harden on adhering and build up as a solid mass, or else it will be fluid at the moment of contact and will drip from the tubes or run down the wall. Between these two conditions may be a combination of the two, in which slag will run at high rating and build up during low ratings.

The effect of slag accumulation on boiler tubes is to reduce the gas passages, cut down heat transmission, and lower boiler capacity and efficiency. Slag accumulation on boiler tubes usually sets the end of the operating cycle of the boiler, when it must be taken off the line for cleaning of heating surfaces.

SOFTENING TEMPERATURES OF ASH

| Sample | Softening Temp., Deg.F. | SiO | $Al_2O_3$ | $Fe_2O_3$ | $TiO_3$ | CaO | MgO | $Na_2O$ | $K_2O$ | $SO_2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2,060 | 31.7 | 19.6 | 18.9 | 1.1 | 11.3 | 3.7 | 1.9 | 0.5 | 12.2 |
| 2 | 2,320 | 46.2 | 22.9 | 7.7 | 1.0 | 10.1 | 1.6 | 0.7 | 0.8 | 8.9 |
| 3 | 2,500 | 49.7 | 26.8 | 11.4 | 1.2 | 4.2 | 0.8 | 1.6 | 1.3 | 2.5 |
| 4 | 2,730 | 51.0 | 30.9 | 10.7 | 1.9 | 2.1 | 0.9 | 1.0 | 0.4 | 0.6 |
| 5 | 2,900 | 58.5 | 30.6 | 4.2 | 1.8 | 2.0 | 0.4 | 0.7 | 0.9 | 0.9 |

Slag formation on refractory walls is of primary importance in determining the life of the boiler setting. Slag accumulations on furnace walls give rise to two causes of failure of refractory, depending on the nature of the slag. If the slag deposits in a molten condition and flows down the wall, the erosive action of the fluid ash is highly destructive to the refractory material, not only on account of the washing action, but also because of chemical reaction between slag and refractory, which may lower the fusing temperature of the combination and engender a more severe action than washing alone. If the slag adheres to the refractory and builds up as a hard, dense mass, it will break off part of the face of the refractory when it is removed from the wall.

The disposal of ash is another problem upon which slagging has an appreciable effect. In stoker-fired furnaces the adhesion of slag to stoker dump plates may be a serious problem. The building up of slag deposits and their consequent flowing down the walls at high ratings gives rise to a difficult disposal problem, as the deposits build up in the ashpit and cannot be removed without shutting down the furnace and breaking out the slag. The building up of slag by dripping from the boiler tubes is another problem of similar nature.

In general, the effect of slag accumulation is to lower efficiency, increase wall maintenance and boiler outage, aggravate the problem of ash disposal, and set a limit on the rating at which the boiler can be operated.

## Methods of Overcoming Slag Problems

Complete elimination of slag accumulation depends either on operating at such ideal conditions that no slag will form, or on designing boiler furnaces of such a nature that conditions favoring slag formation will not exist. Ideal conditions which will prevent slag formation would involve operating the boiler at such a rating that only a small amount of ash is carried from the fuel bed, since slag formation is roughly proportional to the ash in the gases and the amount of gases and ash increases with rating. A second condition of ideal operation would be to maintain a rating low enough so that the temperature of the furnace would not rise above the point at which the ash fuses. A third condition requires the maintenance of an oxidizing atmosphere in the combustion chamber.

Operation with pulverized coal would depend upon the same conditions as for stokers, with the exception that the ash would already be floating in the gases; hence the maintenance of a relatively low temperature and an oxidizing atmosphere would be absolutely necessary. Operation at such conditions as to eliminate slagging with pulverized coal is manifestly more difficult than with stokers.

It can easily be seen that operating at such ideal conditions as to eliminate slag formation would seriously limit boiler capacity and efficiency, and might not be worth while from the standpoint of economy, that is, from the standpoint of utilization of investment. Operation is thus a matter of balancing cost of slag removal against gain through increased capacity with consequent slagging.

A number of methods of controlling slagging have been developed, both in design and in operation, with varying success. These methods in general fall under three classifications: reduction of the amount of ash carried by the gases; removal of accumulations during formation; and providing means of lowering furnace temperature so that the ash particles will be cooled before they come in contact with heating surfaces.

Reduction of the amount of ash carried by the gases, from the standpoint of operating control of slagging, which is applicable to any installation, involves several features of plant operation. Washing of coal is effective in reducing the ash content. Tests show that as much as 50 per cent of the total ash in the coal has been removed by washing. Washing of coal also deserves consideration in connection with the fly ash problem. Adoption of coal containing the smallest quantity of fines will reduce the ash in the gas in stoker firing, and it has been shown that the combustible loss and slagging in pulverized-coal firing decreases considerably as the percentage of coal through a 200-mesh screen increases, since the smaller particles burn out more quickly and lose heat before striking the boiler tubes. Wetting down of coal on a stoker tends to hold the particles in place and less ash is carried away.

The removal of slag from heating surfaces by hand lancing, or steam, water or air lancing is another operating feature applicable to any installation. This method of slag removal is useful in controlling slagging up to a certain point, but it does not take the place of thorough cleaning at intervals. Lancing of slag will not remove all slag accumulation; hence the efficiency of the unit gradually falls until cleaning is necessary.

In the field of boiler design the same general methods of slag prevention apply. Reducing the amount of ash carried by the gases may be effected somewhat by decreasing the velocity of the gases. This may be done by arranging the arches so as to give the largest gas space consistent with good combustion conditions.

A second application of this method is designing of the furnace so that the gases undergo a sudden change in direction, thus dropping out a large part of the ash. A design may be conceived in which combustion takes place in a chamber walled with steam or water-cooled elements, which would resist the action of the slag and in which a convection or boiler section receives the gas after a change in its direction to drop out most of the ash.

## Air and Water Cooling

Cooling of the furnace to lower the temperature of ash particles has received a great deal of attention from designers and may be considered both from the standpoint of protecting the furnace wall and preventing slag accumulation on heating surface, although protection of a furnace wall by cooling will also protect the heating surfaces to an extent.

Probably the most important method of cooling ash particles is by providing means of absorbing heat radiated to the walls, since any heat removed by radiation decreases slagging. The two most common methods of absorbing heat radiated to the walls are air cooling and water cooling.

Air cooling of refractory walls is more applicable to maintaining the furnace wall temperature low enough to keep a protective coating of slag on the wall rather than to cooling the furnace itself to the point where ash particles will not deposit on boiler tubes. When the fusing temperature of the ash is relatively high, and the energy release per cubic foot is moderate, air cooling is successful in protecting the wall.

Water-cooled walls are not harmed by the washing action of molten slag, providing burning of the tubes is

prevented by adequate circulation. Slag will run on water walls only at very high ratings, as the wall temperature is usually low enough to maintain a protective coating of slag on the walls. The application of water-cooled walls to boiler furnaces has proved of immense value in solving wall maintenance and reducing slagging.

Another method of cooling ash particles is by slag screens, placed either just below the lowest bank of boiler tubes or directly above the ashpit. In the first case, the screen cools the ash particles just before they enter the banks of boiler tubes, and the accumulated slag drips into the ashpit or is lanced off. In the second case, the screen is intended to cool the ash particles so that they will not accumulate in molten form in the ash pit. Slag which is retained in the ashpit in molten form and then cooled is difficult to remove.

The problem of slag accumulation in molten form in the ashpit led to the development of the slag-tap furnace, in which the slag is collected in the fluid state and tapped out at intervals. The slagging-bottom furnace possesses several features which are of use in preventing slag formation. One of these is the application of vertical firing in which coal is fired downward onto the molten slag, so that the gases reverse and deposit some of the ash. This method has proved successful in a number of large plants.

In conclusion, the problem of slag formation in boiler furnaces necessitates considerable care in both design and operation of the furnaces. At the high ratings of the present day, cooling of furnaces is an absolute necessity in order to control slagging and prevent the aggravation of slag troubles which high ratings bring. The absorption of a larger portion of the energy liberated in the furnace by radiant-heat-absorbing surface to secure better control of furnace temperature is worthy of attention by designers.

The reduction in the amount of the ash entering the furnace brought about by washing of coal does not seem to be sufficiently appreciated in plant operation. The possibilities that this practice offers in controlling slag formation would seem to merit further investigation.

The author acknowledges his indebtedness to the United States Bureau of Mines, to the University of Illinois Engineering Experiment Station, and to the Prime Movers Committee of the National Electric Light Association for information included in this article.

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# Insuring Accuracy of Steam-Flow Meter Readings

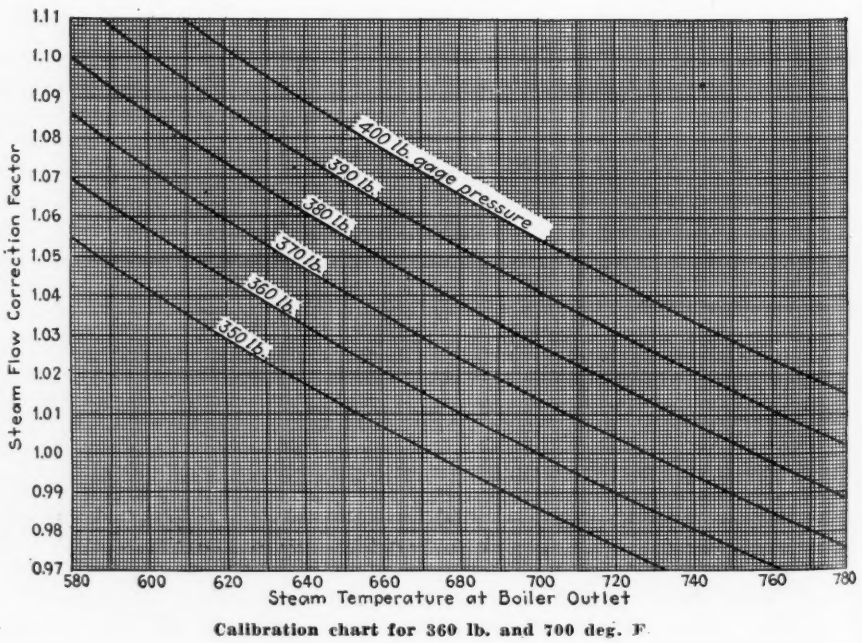
By M. F. KNOY

MANY boiler plants use orifice meters to determine the rate of steam flow as well as the hourly and daily total output from the individual boilers. Such meters are accurate provided they are properly maintained and the proper corrections for steam pressure and temperature are made. But these precautions must be observed if the meter readings are to form a reliable basis for cost determinations, steam sales, or the efficiency of the individual firemen.

Cases have been known in which meter readings were used in cost determinations without any effort on the part of those responsible to assure themselves as to the accuracy of the meters. In other cases leaky condensers or differential piping have been continued in service for months, excluding all possibility of obtaining correct readings. A less glaring oversight on the part of the engineer is to neglect a periodic inspection of the orifice itself. Any deformation or partial obstruction of the orifice by scale, salt deposits, corrosion, erosion, etc., will impair the accuracy of the instrument.

Perhaps the most prevalent cause of inaccuracy is the failure to make proper corrections for temperature and pressure variations. The meters are of necessity calibrated for only one temperature and one pressure, and corrections must be made if either or both of these properties vary. Sometimes the manufacturer's correction graphs never reach the operator, and in other cases they are misplaced by the operator as soon as the newness of the meter has worn off. The result is that many plants operate regularly without making any temperature or pressure corrections. The engineer may make every effort to determine the exact amount of fuel consumed and then use for his reports steam meter readings that are in error by 5 per cent or more.

Even where the manufacturer's correction curves are used faithfully there may be some errors in making corrections due to coarse graduations on the scales used and




**Calibration chart for 360 lb. and 700 deg. F**

the consequent necessity of interpolating. Also, too frequently the manufacturer supplies two correction graphs, one for pressure and the other for temperature or quality. Thus by the time the operator makes several rough interpolations and combines the two factors his final correction factor may be considerably in error.

I have found that the most satisfactory correction graph is one which combines both temperature and pressure on a finely ruled chart that will permit of very close interpolation. Such a chart is here shown. With such a set of curves one can easily determine a factor accurately within one-tenth of 1 per cent. This chart is made for a meter calibrated at 360 lb. and 700 deg. F., and under these conditions the factor will, of course be unity. But assume that the conditions change to 380 lb. and 600 deg. Spot 600 deg. on the lower scale and from this point follow the vertical line to where it intersects the 380 lb. curve; then follow the horizontal line to the scale on the left-hand margin and read the factor as 1.055. In like manner the factor may be readily found for any pressure from 350 to 400 lb. and for any temperature from 580 to 780 deg. No interpolation is required for temperature, as the vertical lines are spaced at intervals of only one degree. Interpolations for pressure are easily made.

Such a chart as this may be made by plotting the combined temperature and pressure factors as determined from the manufacturer's correction curves. The best way, however, is to calculate them from the data given in an up-to-date steam table. It is changing the steam density that causes an orifice meter to be in error, whether the density change is due to a change in temperature or to a change in pressure. Since the sole problem is to correct for changes in steam density, one might as well use the densities given in the steam table. If only specific volume is given in the table that is just as well for the purpose, since volume is the reciprocal of density and may readily be used in calculating correction factors.

Since for a given differential the actual weight of steam flowing per hour will vary inversely as the square root of the volume, one may calculate the correction factor for any steam condition by means of the formula $F = \sqrt{\frac{V_o}{V_1}}$, in which $F$ is the correction factor, $V_o$ is the specific volume at the temperature and pressure for which the meter is calibrated, and $V_1$ is the specific volume of the steam under actual conditions. If it is desired to use logarithms to calculate the factors the following formula may be used:

$$\text{Log } F = \frac{\log V_o - \log V_1}{2}$$

The best plan is to tabulate the factors for a given pressure at 10-deg. intervals over the temperature range that is expected in practice; then do the same for various pressures at intervals of 10 lb. over the pressure range that is expected in practice. The results may then be plotted on a correction chart similar to the one shown.

Finally, some boilers show a wide variation in steam temperature at different ratings, and sometimes the pressure also is allowed to fluctuate between low load and high load. In plants where the daily load factor is low the failure to make corrections for these variations may not only cause serious error in the apparent total output but may also reflect unfairly upon the firemen on one or another of the watches.

# Engineers Work Toward Elimination of Noise

HOPE for the elimination of much of the noise created by machines and present in everyday life was expressed by Sidney K. Wolf, director of the acoustic consulting service of Electrical Research Products, Inc., of New York, in a recent address before the American Philosophical Society in Philadelphia.

"The machine age, in addition to major sociological and economic changes, is characterized by an amount of noise in human experience. A sensitive person viewing our civilization might be led to conclude that there exists a squalor of noises in a world of mechanical splendors," said Mr. Wolf. "Because of these noises, such typical branches of engineering as civil, mechanical and communication have had to turn their thoughts to a new field which may be called noise engineering.

"Since noise in a modern life is, in one sense, largely due to the engineer, it seems fitting that the engineer should now concern himself with ameliorating existing conditions. The program adopted by the noise engineer to war on noise may be classified into fields related to the several branches of engineering. The first principle of the noise engineer, avoidance of its generation, is highly applicable in other fields, mechanical engineering being the most prominent. If our machines can be made silent in operation, the first great step forward will be realized. Factories, offices and homes, even, can be quietly peaceful compared to present conditions. The transportation fields offer great possibilities in this respect. Automobiles, subways, trolleys and airplanes are all noisy but are all undergoing study and improvement.

"The second principle of the noise engineers, to avoid sound and vibration transmission, is obviously important to the construction man and also to the mechanical engineer. It is the duty of architects and builders to supply substantial soundproof buildings. To keep out noise, homes of the future may employ windows for light and observation only, air being obtained through auxiliary, soundproof inlets. The third principle, to absorb sound, has its application after other principles have been tried. The ventilating expert uses it to produce silent ventilating ducts and window attachments, and there are other similar uses for diminishing the intensity and sensation value of noise.

"I feel that I am not being too optimistic when I say that progress is being made all along the line. Recently in New York City we made an extensive noise survey of subway and elevated lines. The study included consideration of the type of roadbed, type of tunnel construction, type of elevated structure, type of rolling stock, etc., all with the thought that each link should be designed to achieve quiet conditions.

"The program is an idealistic one but nevertheless admits of practical realization."

▼

IN THE FORMULA for the flow of water in rubber-lined hose, *Power*, April 5, page 518, the expression for $K$ should have read:

$$K = 1.318 \left(\frac{D}{4}\right)^{0.13} \times S^{0.04}$$

Through an error in copying, the exponents were published as coefficients.

# Regulating Natural-Gas Fires For Best Efficiency

By NEWTON E. EBAUGH
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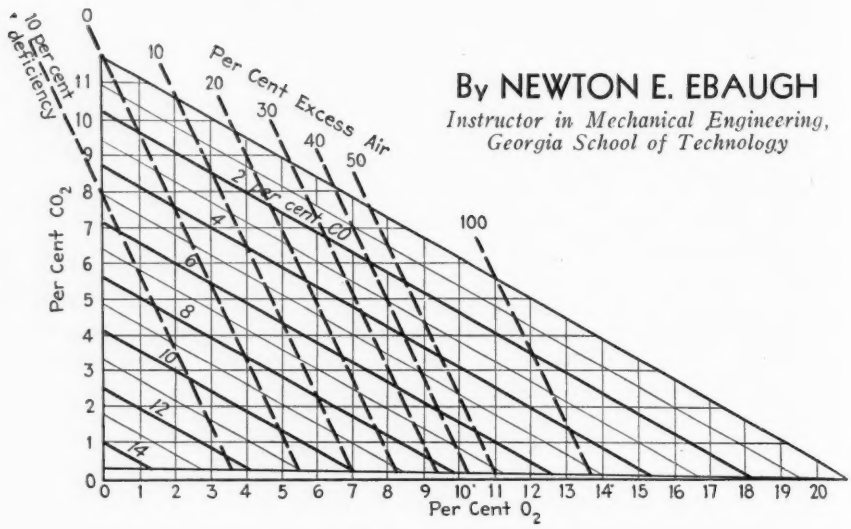



**Fig. 1—Flue-gas-analysis chart**

**Using flue gas analysis for $CO_2$ and $O_2$, charts show corresponding CO, excess air and total flue loss for natural gas consisting mainly of methane**

WITH THE recent rapid expansion in the distribution of natural gas many industries are taking advantage of this ideal fuel which is delivered to the user's furnace, eliminates all ash-handling equipment and labor, and which readily lends itself to close regulation.

### Heat Losses With Natural Gas

Heat losses which occur when natural gas is used as a fuel can be divided into two groups: radiation from the furnace setting, and heat carried out by the hot flue gases. The second of these losses is by far the greater and will be considered in this article.

The heat carried out in the flue gases may be divided into three parts. First, there is a loss of heat due to combustible gas existing in the flue gas; second, there is a loss of heat due to the fact that the dry flue gas leaves at a temperature higher than that of the initial fuel and air mixture; third, heat is lost due to the water vapor in the flue gas as a product of combustion.

The combustible gas in the flue gas consists chiefly of carbon monoxide, CO, which is highly poisonous and causes a large loss in heat. Some industrial furnaces must operate with CO in the flue gas in order to prevent oxidation of the product being handled in the furnace, but CO would be highly undesirable for the majority of furnaces. Carbon monoxide is usually caused by an insufficient air supply or a burner which (although is supplied with sufficient air) does not thoroughly mix the fuel and air.

The best method to determine the right amount of air to be used with a fuel, as well as the resulting combustion efficiency, is to analyze the flue gas with Orsat apparatus. This gives the per cent by volume of $CO_2$ (carbon dioxide) $O_2$ (oxygen) and CO (carbon monoxide) existing in the dry flue gas.

### Flue Gas Analysis Chart

Only one combination of $CO_2$, $O_2$, and CO is possible for a given burner setting with natural gas. All possible combinations of these constituents for a typical natural gas from the north Louisiana fields are shown in Fig. 1. The gas for which this chart is calculated has the following volumetric analysis:

| | |
|---|---|
| Methane, $CH_4$ | 96.5 per cent |
| Ethane, $C_2H_6$ | 0.0 per cent |
| Nitrogen, $N_2$ | 2.1 per cent |
| Carbon dioxide, $CO_2$ | 1.4 per cent |

However, this chart will be very nearly correct for all natural gases rich in methane and low in carbon dioxide content. This method of presenting the Orsat analysis data is originally credited to the eminent German chemist, W. Ostwald.

### Checking Orsat Analysis

The flue-gas-analysis chart may be used as a check on the accuracy of the Orsat analysis. Thus if the Orsat analysis shows 8.5 per cent $CO_2$ and 3 per cent $O_2$, it must also show 2 per cent CO. Furthermore, this analysis can only be secured when 10 per cent of excess air is used. Thus CO may appear in the flue gas when excess air is being used. This condition could be brought about by imperfect mixing at the burner or by insufficient air at the burner and subsequent air infiltration through cracks in the setting. Fig. 1 shows that with perfect combustion and 10 per cent excess air there will be 10.5 per cent $CO_2$, 2 per cent $O_2$, and no CO.

### Not Necessary to Measure CO

The determination of the CO content of flue gas is the hardest one to obtain accurately. It is, however, not necessary to measure the CO content when a chart such as Fig. 1 is available. If the $CO_2$ and $O_2$ are measured, the value of the CO can be read from the chart. Therefore, if the $CO_2$ and $O_2$ are measured, the CO content, the per cent excess air being used, and whether or not

complete combustion is attained may all be found from the flue-gas-analysis chart.

Fig. 2 shows the per cent of the heating value of the natural gas which is lost in the dry flue gas, for different stack temperatures. These curves are computed for an initial air temperature of 70 deg. F. For illustration, if the stack temperature is 500 deg., the following percentages of the heating value of the gas will be lost in the stack gases:

| *Conditions Taken from Fig. 1* | *Loss Taken From Fig. 2 Per Cent* |
|---|---|
| 1. Perfect combustion — no excess air<br>11.7 per cent $CO_2$, 0.0 per cent $O_2$, 0.0 per cent CO... | 7.0 |
| 2. Perfect combustion — 10 per cent excess air<br>10.5 per cent $CO_2$, 2 per cent $O_2$, 0.0 per cent CO..... | 7.8 |
| 3. Perfect combustion — 50 per cent excess air<br>7.5 per cent $CO_2$, 7.5 per cent $O_2$, 0.0 per cent CO... | 10.7 |
| 4. Improper mixing or infiltration — 10 per cent excess air<br>8.5 per cent $CO_2$, 3 per cent $O_2$, 2 per cent CO..... | 14.0 |

These values, together with Fig. 2, illustrate the fact that moderate amounts of excess air will not greatly increase the stack loss. On the other hand, the presence of carbon monoxide in the gas greatly increases the stack loss. It is therefore much better to adjust the gas burners until the flue-gas analysis shows a slight amount of excess air in order to insure against the formation of CO. The better gas burners will eliminate the CO if a slight amount of excess air is used.

### Loss Due To Water Vapor

Every fuel which contains hydrogen as one of its elements will form water vapor upon burning. This water vapor often causes the largest loss of heat experienced during the combustion of natural gas, as can be readily seen by referring to the water-vapor-loss curve on Fig. 2. For illustration, if the flue-gas temperature is 500 deg., the heat carried out by the water vapor will amount to 11.7 per cent of the heating value of the fuel. Unfortunately, the fireman can do little to decrease this loss, because the adjustment of the burner affects it but little.

### Summing Up

It has been demonstrated that, if the carbon dioxide and oxygen contents of the flue gas from a furnace are measured with the aid of Fig. 1, the carbon monoxide content of the flue gas may be determined, that is, whether or not complete combustion is attained. In addition, the amount of the excess of air or deficiency of air may be determined by making use of Fig. 1.

The information plotted in Fig. 2 may be used to estimate the efficiency of a given installation. For example, if the flue-gas temperature leaving a boiler is 500 deg., and if 10 per cent excess air is used with complete combustion, 7.8 per cent of the heating value of the fuel will be carried out by the dry flue gas and 11.7 per cent will be carried out by the water vapor. If it is assumed that radiation and "unaccounted-for" losses amount to 2 per cent of the heating value of the fuel, the overall boiler and furnace efficiency will be 78.5 per cent.

# Smoke Abatement in England

IN ENGLAND, even more than in America, attention has been directed to the smoke problem. For that reason smoke-abatement devices and methods developed in England are being carefully considered here. Correspondingly, American advances are being closely followed by English engineers with a view to possible application in that country.

An example is the recent research of H. F. Johnstone at the University of Illinois. He has shown that manganese salts can be used to oxidize sulphur dioxide in flue gases into sulphur trioxide. The latter is far more soluble in water than the former, so that the amount of water required to wash out the sulphur gases in flue gas can be reduced from about 20 tons per ton of coal to about $1\frac{1}{4}$ tons.

Interesting comments on the smoke-abatement problem from the British point of view were contained in a paper presented by V. R. Chadwick before a joint meeting of the members of the Institute of Fuel and the Society of Chemical Industries at Bristol University recently.

Mr. Chadwick pointed out the difficulties of enforcing fairly any cut-and-dried laws regarding smoke emission. He pointed to the domestic chimney as by far the greatest offender, not only in total volume of smoke emitted but in the proportion of tarry material. Domestic chimneys give a higher percentage of tar because their furnaces operate at lower temperature. It is hardly possible for this nuisance to be eliminated so long as houses continue to use smoky fuel. It is also impracticable at the present time, he said, for most domestic users in Great Britain to use the smokeless fuel.

A computation made by Mr. Chadwick indicated that the daily emission of smoke and fumes from domestic chimneys would put a blanket over England, Scotland and Wales 3.6 in. thick, whereas that from industrial chimneys would be equal to a blanket 1.2 in. thick.

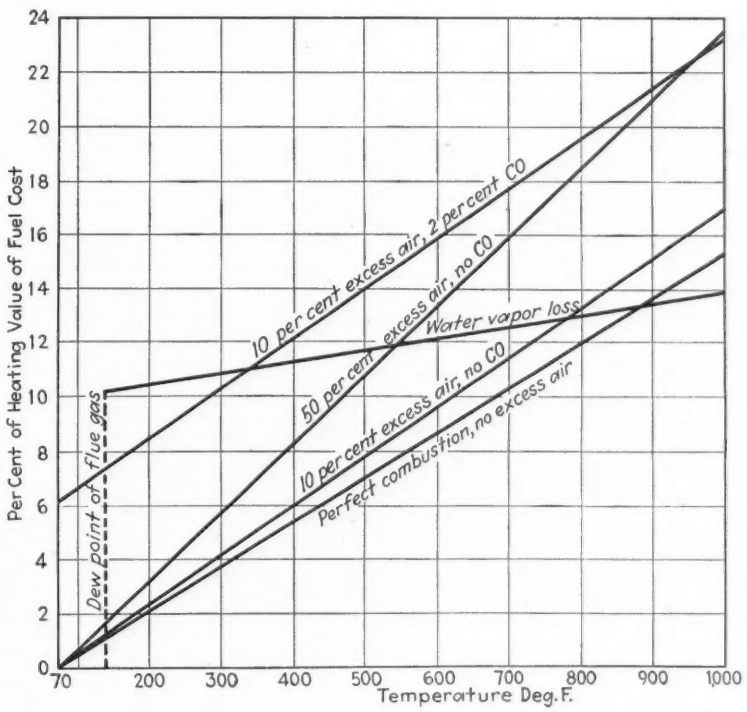

Per Cent of Heating Value of Fuel Cost
Temperature Deg. F.
Dew point of flue gas
10 per cent excess air, 2 per cent CO
10 per cent excess air, no CO
Water vapor loss
50 per cent excess air, no CO
10 per cent excess air, no CO
Perfect combustion, no excess air

**Fig. 2—Heat losses resulting from the combination of natural gas**

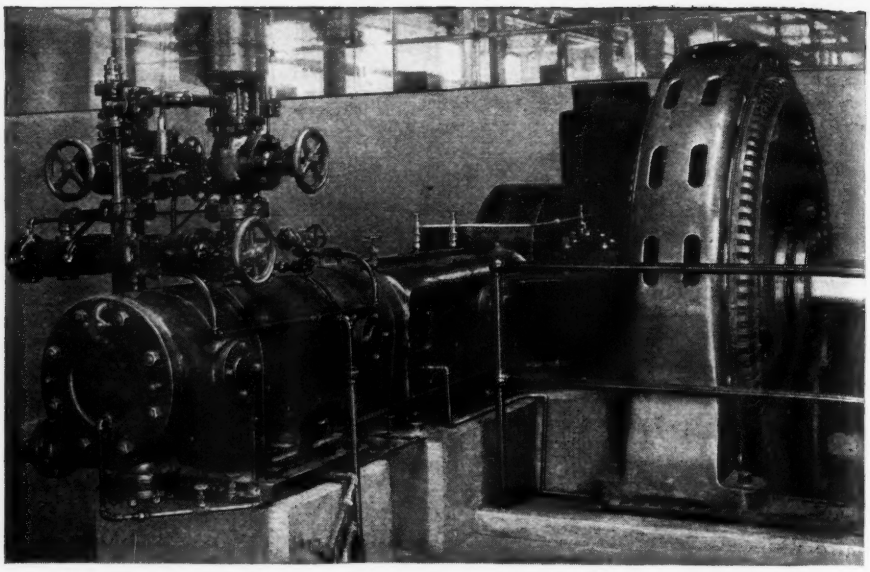


Fig. 1 — Horizontal double-acting duplex ammonia compressor equipped with instantaneous unloaders

# Compressor Synchronous Motors Start and Stop Automatically

**Need of manual bypassing ror ammonia compressors is eliminated by automatic unloader. This unloader permits automatic start and stop operation for synchronous-motor-driven plants. Instantaneous operation prevents compressor shutdowns during voltage dips, simplifies operation of starting and improves plant reliability**

By S. P. BORDEAU
*Electric Machinery Mfg. Co.*

THERE is a trend in large ice and refrigeration plants toward automatic control of the refrigerating units. With automatic control greater reliability is obtained, due to prevention of abnormal or improper operation of important parts of the system. Automatic control of plant capacity is being secured by equipping one or more of the compressor units for complete automatic start and stop operation, these units starting up and shutting down with the plant requirements. This relieves the operator of constant watch on the equipment and promotes continuous operation.

Synchronous motors are quite generally accepted for larger ammonia-compressor drives. Because they can be directly connected at slow speeds, have high efficiency and correct power factor, these motors are well fitted to this service. In common with most other electric drives, however, they are under the handicap of not being able to start the compressor against the full head pressure of the system.

Slow-speed synchronous motors for direct connection to refrigerating compressors usually have approximately 40 per cent starting torque and 40 per cent pull-in torque. To meet the needs of starting under full load over 100 per cent starting and pull-in torque would be necessary. To design the motor for these requirments would be impractical because of high first cost and reduced efficiency under full load. For these reasons it has been necessary in the past on synchronous-motor-driven compressors to unload or bypass the suction and discharge. This was accomplished manually by opening a valve in the bypass connection before starting and closing it again when the motor was up to speed and synchronized.

To obtain entirely automatic starting it is necessary to provide not only automatic control for the motor, but also to make the unloading operation automatic. With this unloader and automatic synchronous-motor control, bypassing is accomplished automatically and instantaneously without attention on the part of the operator.

The instantaneous unloader is an automatic, pressure-differential-operated bypass valve connected between the suction and discharge on the compressor, as in Fig. 2. Valve *A* is shown in the closed position and shuts off the bypass connection betwen the discharge and the suction side of the ammonia compressor. Under this condition

the compressor is operating normally, that is, delivering gas from the suction to the discharge line. Ammonia gas under discharge pressure holds the unloader valve *A* closed. This gas is supplied at *D* through a regulating valve *E* from the high-pressure line on the condenser side of the check valve. Pilot valve *C* is normally closed. Sequence of operations in starting the compressor are:

The start button is pressed, causing the motor line switch to close and energize the stator winding of the synchronous motor. The field winding of the motor is energized with current induced in it by transformer action from the stator, but decreases as the motor approaches synchronous speed. Since the solenoid winding of pilot valve *C* is in series with the motor-field winding, it will also be energized as soon as the motor is started and the pilot valve is opened. Opening pilot valve *C* causes the pressure behind piston *B* to be reduced to slightly above suction. This is done by allowing the ammonia gas to flow through the pilot valve into the suction line faster than it flows from the discharge line through regulating valve *E*.

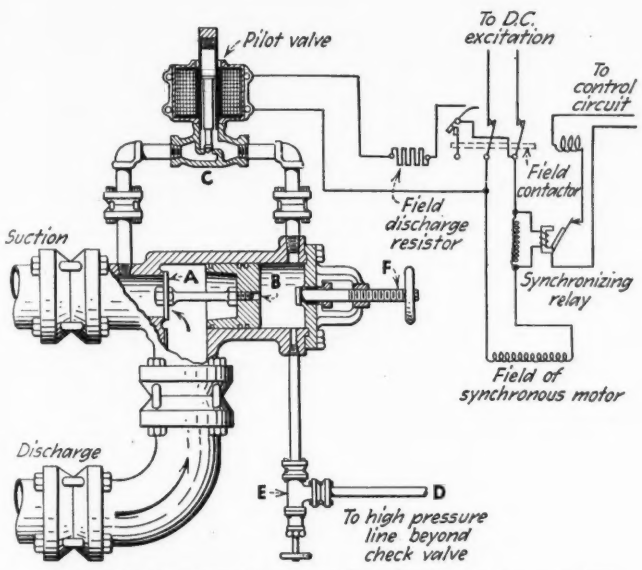



**Fig. 2—Section through automatic unloader and connections to motor starter**

Discharge pressure acting on the left-hand side of piston *B* opens valve *A* quickly. The piston is stopped by the cushioning action of the gas behind it, as the gas cannot dissipate through pilot valve *C* to the suction line as fast as it is compressed by piston *B* when opening. Thus, the valve opens quickly and noiselessly. As soon as valve *A* opens the high-pressure gas is relieved from the left-hand side of piston *B*, as it discharges into the suction line. The compressor now operates unloaded and the synchronous motor accelerates and synchronizes.

When the motor has synchronized, the field discharge current dies out and pilot valve *C* closes, thus preventing escape of high-pressure gas from the regulating valve into the suction line. In a second or two the pressure back of piston *B* is sufficient to cause it to close against the suction pressure, which is now applied to the left-hand side of this piston. When regulating valve *E* is correctly adjusted, the unloader valve closes with only a slight tap on its seat. High-pressure gas acting on valve *A* holds it tightly closed. The compressor is now loaded and assumes normal operation. This entire cycle is accomplished in a very few seconds.

The sequence of operation after a voltage dip is the same as has been described. When the voltage drops sufficiently to cause the motor to slow down below synchronous speed, the synchronizing relay immediately closes, removing field excitation, and pilot-valve *C* is energized and unloads the compressor. With the compressor running light and field excitation removed, the motor immediately resynchronizes and resumes load, as soon as the voltage becomes normal. Screw *F* provides for infrequent cases where the system pressures are equalized, when it may be necessary to close valve *A* manually until the pressures become normal.

In the ice and refrigeration industry much attention is being given to the advantages of automatic start and

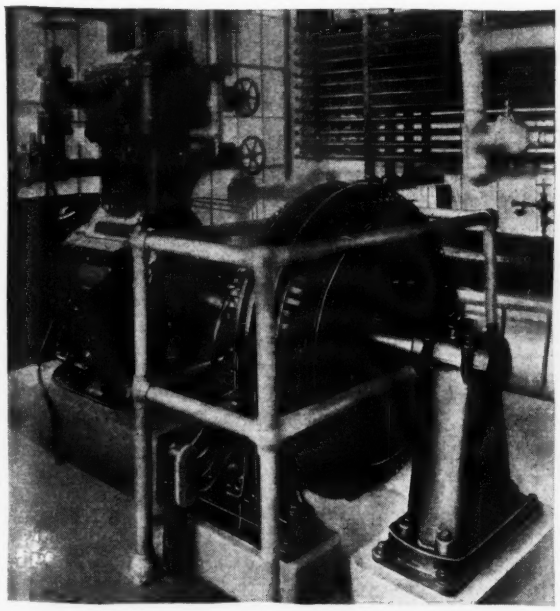


**Fig. 3—Ammonia compressor equipped with automatic unloader and driven by a 60-hp. synchronous motor**

Mounted on the meter panel on the left in Fig. 4 is a water-pressure gage *A*; brine-pressure gage *B*; high-pressure-ammonia gage *C*; low-pressure -ammonia gage *D*; room-temperature thermometer *E*; low-pressure-ammonia contact switch *F*; high-pressure-ammonia contact switch *G*; low-water-pressure cutout *H*; low-brine-pressure

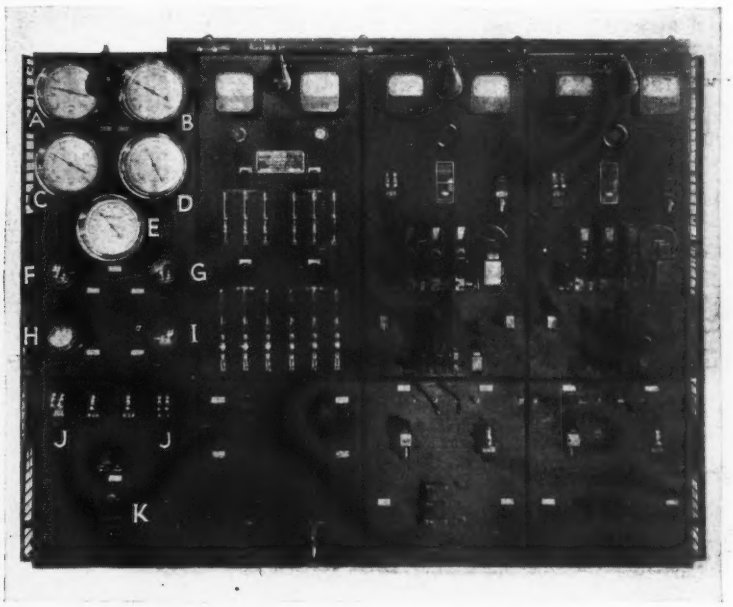



**Fig. 4—Control panel for automatically starting and stopping the motor-driven compressor Fig. 3 and another unit**

contact switch *I*; protective relays *J* actuated by the contact switches; an alarm bell *K* to indicate accidental shutdown of either unit. The panel next to the meter panel is for motor-generator and brine-pump motor control. The two panels on the right are for control of the two synchronous motors.

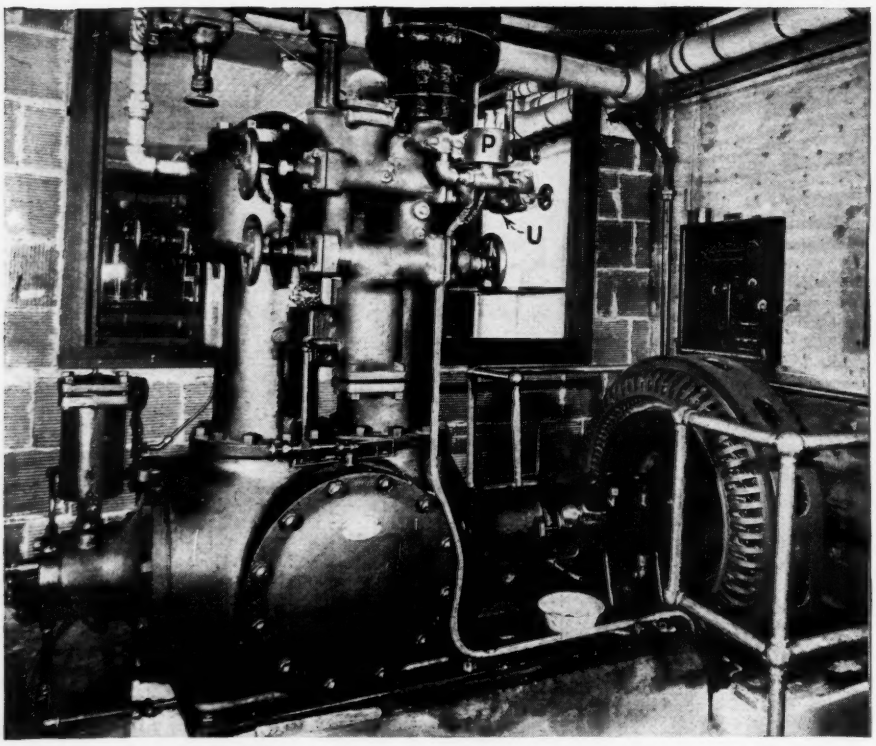



Fig. 5—A 75-hp. synchronous-motor-driven vertical ammonia compressor equipped with automatic unloader

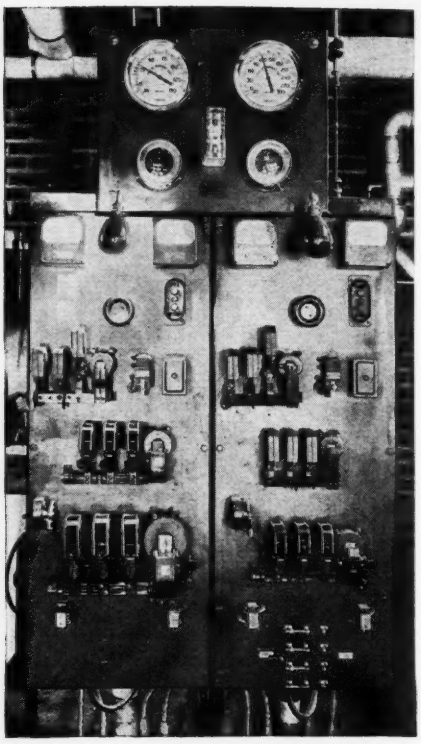


Fig. 6—Starter for the unit Fig. 5 and another machine

stop operation. The last year has seen several large installations of this kind. It is in new plants, particularly where the necessary auxiliary equipment can be built in, that the greatest possibilities of this type of installation are being considered. In some plants where variable plant capacity automatically maintained is desired, several of the compressor units may run continuously and one or two only equipped for automatic start-and-stop operation. The operation of one or more compressor units can be made entirely automatic, starting and stopping by brine thermostats, suction-pressure control or other means to maintain the desired temperatures.

Reliability of compressor operation is important in refrigeration plants. Forced shutdowns from any cause may mean an expensive loss in refrigeration. The instantaneous unloader provides insurance against one cause of forced shutdowns, momentary power supply disturbances, commonly called voltage dips. In certain localities voltage dips are frequent, and each dip may cause a shutdown of the compressor units. Where there are several compressors and the power goes off momentarily, it takes the attendant a considerable time to operate all the bypasses manually and get the plant running again. Compressors equipped with the instantaneous unloader and with frequency-responsive control run through the periods of voltage dips without attention and without interruption.

The value of automatic control will be readily seen for plants where the operator must spend much of his time outside the compressor room, such as in plants where one man must make, harvest and sell the ice. With the proper synchronous-motor control, and the instantaneous-unloader, the operator can work outside the compressor room with the assurance that operation of the motor will not be interrupted except by complete failure of power. Even where the operator is in continuous attendance, there is advantage in the simplified motor and compressor starting afforded by the unloader. The compressor is started in a minimum of time by merely pressing the motor start button.

The instantaneous unloader can be applied to practically any type of ammonia compressor, and in old or new installations where synchronous motor drives with automatic starters are used. For full-automatic start-and-stop plants, use of the instantaneous unloader is preferably limited to new installations or extensions of older installations where the necessary thermostatic or suction-pressure control, water regulators, high- and low-pressure cutout devices, indicators, motor starters, etc., can be included in the original plant layout. However, where automatic unloading only is desired, and the proper motor control equipment is available, the instantaneous unloader can be installed at comparatively low cost. The only precaution necessary is that proper arrangements are made to prevent slugs of ammonia liquor from being drawn into the compressor cylinder from the suction pipe.

Figs. 3 and 4 show one of the compressor units and the control board at the Willard State Hospital, Willard, N. Y., automatic refrigeration plant. Two compressors are each driven by 60-hp., 240-r.p.m. synchronous motors. There are also two sets of condensers, two receivers, two 34-in. diameter by 8-ft. brine coolers, two 150-gal. brine-circulating pumps, and a large brine and an ice-making tank. This duplication of equipment and the mechanical and electrical protective devices provided were installed to minimize the possibility of forced shutdown. The plant capacity consists of seven cold-storage rooms and about one hundred and six 100-lb. cans of ice per day.

Automatic starting and stopping is controlled by brine thermostats set to start the compressor when the brine temperature reaches 14 deg. F. and to stop it when the brine temperature drops to 10 deg. F. The electrically

controlled automatic unloader is placed between the suction and discharge pipe of the compressor cylinder.

Fig. 1 shows the instantaneous unloader applied to a horizontal-duplex ammonia compressor at the Minneapolis Sanitary Ice Company, Minneapolis, Minn. Two unloaders are used, one on each cylinder. This plant is not equipped for automatic start-and-stop operation. The unliaders were installed to simplify the starting of the compressors. Pressing the push button starts the compressor automatically, bypassing during starting being taken care of by the unloader. The unloader also makes the compressor immune to voltage dips.

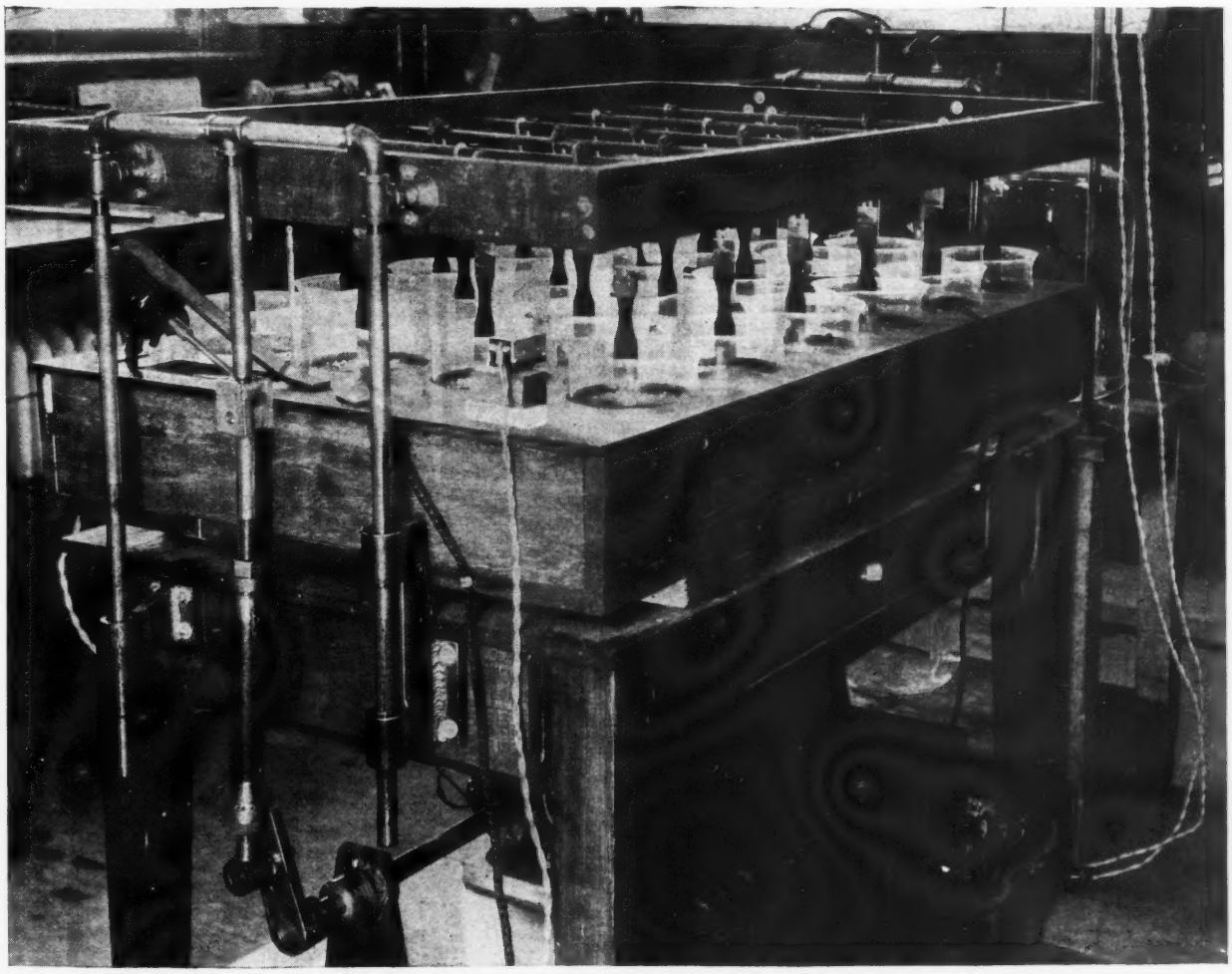
Figs. 5 and 6 show one of the compressor units and its increment part-winding starter at the Olympic Arena, Lake Placid, N. Y. The compressor is driven by a 75-hp., 300-r.p.m. synchronous motor. The unloader and pilot valve are at *U* and *P* respectively. This plant, which also has a $7\frac{1}{2}$x$7\frac{1}{2}$-in. automatic-unloader equipped compressor, is arranged for automatic start-and-stop operation.

▼ ▼ ▼

# MACHINE TESTS CORROSIVE ACTION

TO CORROBORATE many facts already known about corrosion and to uncover others, the Westinghouse Research Laboratories have built a device which greatly hastens the slow process of rust. In it the test specimens are subjected to intermittent immersions in a corroding liquid. The apparatus suddenly immerses the samples for a definite period, leaving them at rest, and then removing and exposing them to air for a definite period. They are moving only when being lowered or raised—a time which is a very small fraction of the cycle.

Samples are suspended from a rack by glass hooks, horse hair, or silk, and a motor-driven crankshaft raises and lowers the rack. The driving motor is controlled by a timing device composed of a synchronous motor operating a contact which causes the motor to periodically turn the crankshaft a half revolution. The timing can be set for any cycle of test operation. To obtain reproducible results the corrosive liquids are kept at a constant temperature by circulating water of a constant temperature along the outside of the vessels containing the corrosive liquids.



**Corrosion-testing machine developed by Westinghouse**

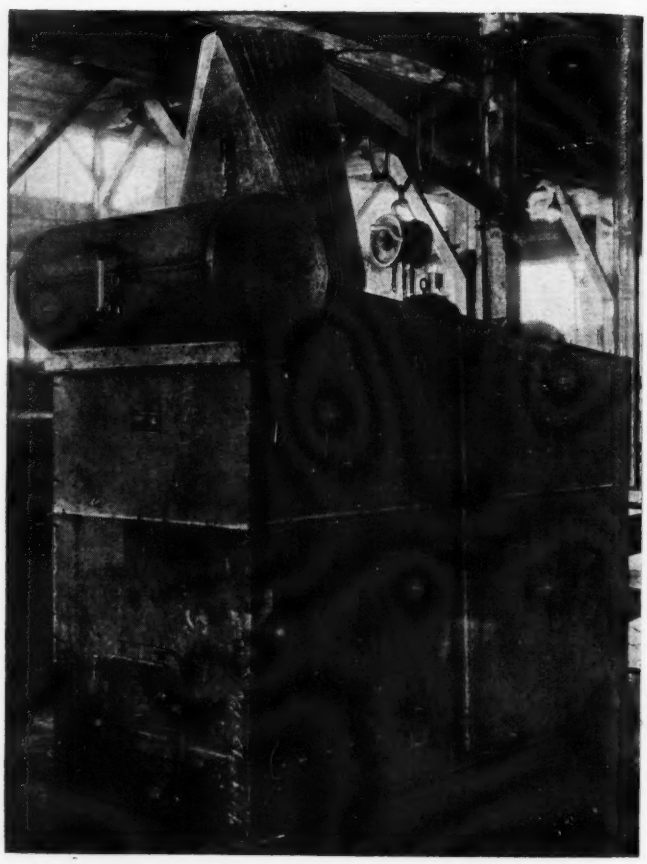
# BY PACK HORSE INTO ALASKAN WILDS

INTO a wild and rugged interior part of Alaska will go a 3,500 sq.ft. arc-welded steam boiler on the backs of horses. This compact unit was built by the Seattle Boiler Works, Seattle, Wash. It was designed so that it could be taken apart and each individual part packed on the back of a horse, and reassembled with simple tools after arrival at its destination. The boiler will be used in diamond drilling operations.

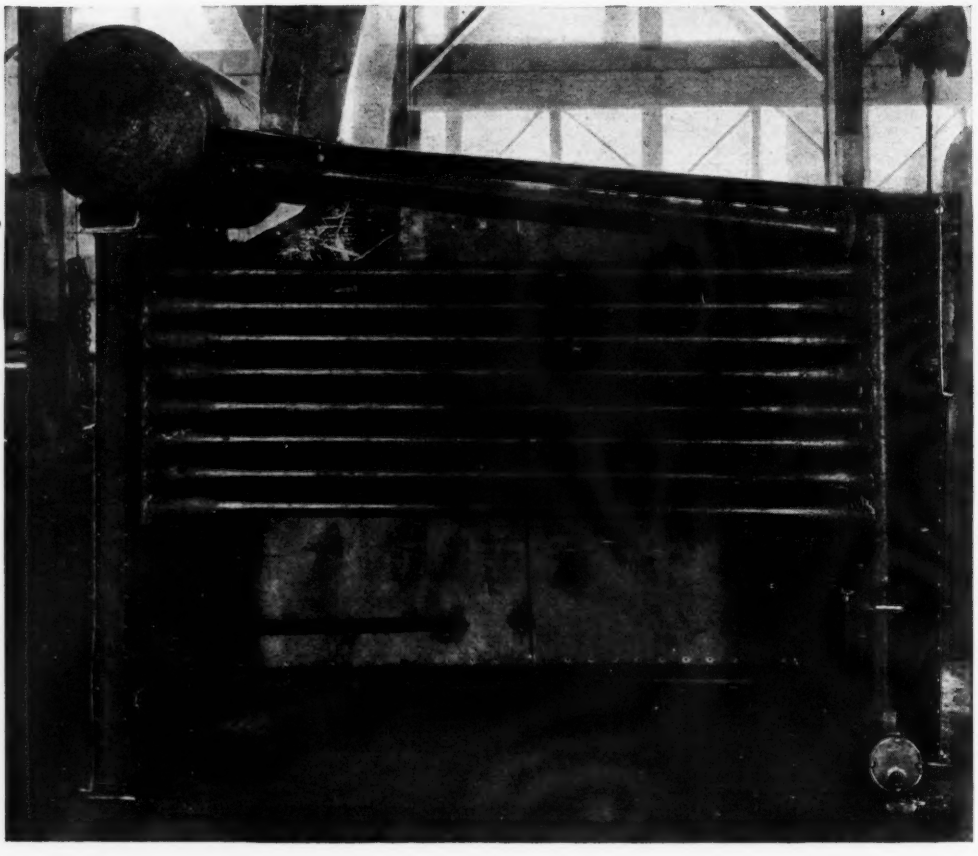
The boiler is 9 ft. 6 in. x 4 ft. 3 in. x 7 ft. It has fifty-four 3-in. o.d. tubes 8 ft. long. The headers are made of 4-in. tubing. The steam drum is 60 in. long with a diameter of 24 in., having a $\frac{1}{4}$-in. thick shell with $\frac{5}{16}$-in. heads. The lining for the fire box will be of firebrick to a height of 4 ft., with one-inch asbestos above the brick.

The 54 tubes are welded into six vertical sections of nine tubes each. The tubes and drum were arc welded by the shielded-arc process using equipment and electrodes manufactured by the Lincoln Electric Company. Welds were tested for an operating pressure of 125 pounds.

Each of the tube units is equipped with flange connections for bolting to the steam drum and headers. This knockdown feature of construction was required by the eventual piece-by-piece transportation of the boiler on the backs of pack horses.



**The boiler assembled and ready to be "taken down" for pack horse shipment**



**A view of the arc-welded tubes, headers and steam drum**

# Increasing the Capacity Of Diesel Engines

By ALAN CRAIGON

IN ATTEMPTING to increase the output unit cylinder volume of a diesel engine one of the solutions adopted by designers is to employ higher mean effective pressures, but if this is obtained through an increase in the compression pressure the peak combustion pressure will be so high that expensive metals will be imperative. The mean effective pressure may also be raised in other ways. For instance, since it is obviously dependent largely on the amount of fuel burned per stroke and since this, in turn, is dependent on the amount of air available to support the combustion, any increase in available air or oxygen may be accompanied by an increase in the fuel injected per stroke.

Supercharging is sometimes used, wherein the air at the beginning of the compression stroke is higher than atmospheric pressure and therefore the amount of oxygen it contains per unit volume is greater. This form of supercharging is beneficial in that clearance volumes may be made larger for the same final compression pressure, which is obviously a function of the initial pressure before compression.

The more fuel burned the longer will be the peak horizontal combustion part of the diesel's indicator diagram and the greater will be the work output. This horizontal combustion part of the indicator diagram might theoretically be prolonged, with injection and combustion occurring throughout the entire working stroke provided that the cylinders contained or were supplied with enough oxygen to support combustion during this period. We should then obtain an indicator diagram wherein the mean effective pressure would be the same value as the compression pressure.

Consider what the heat losses would be if combustion continued for even 40 per cent of the stroke, as in Fig. 1 with an exhaust gas pressure of 200 lb.; consider also the tremendous heat losses through the cylinder walls and head on account of the high temperature maintained for such a length of time.

Compare the steam engine indicator diagram, Fig. 2, with the theoretical diesel diagram, Fig. 3. The long steam-admission period in the steam diagram, with consequent high mean effective pressures, explains the high starting effort that a steam engine can give with a long admission period. It also explains the inability to use a diesel engine directly connected to a load that requires a large amount of power to overcome its inertia, such as a locomotive. With direct connection, the piston speed is necessarily low at starting, but in the case of steam this is compensated for by the high starting torque resulting from the very high mean effective pressure at starting which can be made almost full boiler pressure.

As the diesel cannot increase its starting torque by a high mean effective pressure, due, fundamentally, to the absence of sufficient air to support combustion of fuel injected for such a lengthy period, it must obtain its horsepower and torque in terms of impulses per minute. Recent experiments, however, show that by an exhaust gas turbine supercharging blower it is possible to obtain 10,000 hp. from a nominally rated 4,000-hp. diesel, with a diagram almost like a steam-engine indicator diagram. But this is purely experimental to date.

The logical method is the adoption of the double-acting principle. Speed for speed as against the four-stroke-cycle single-acting diesel, the two-stroke-cycle double-acting diesel will theoretically arrive at full-load torque in one quarter of the time needed by the single-acting four-stroke-cycle engine. It is not beyond the bounds of possibility that the diesel of the future may be made to have all the dynamic characteristics of the steam engine without the latter's thermodynamic disadvantages. However, it would be unreasonable to expect the steam engine to give its excellent starting characteristics with one admission on one side of the piston every fourth stroke, so it is less reasonable to expect this of the diesel.

The designers of four-stroke-cycle single-acting engines today tend to boost the mean effective pressures to higher and higher values, on the basis that since these engines give fewer impulses speed for speed in unit time than do the two-stroke-cycle machines, it will increase the value of these impulses to raise the mean effective pressure. They ignore the limiting features of working gas density and its attendant troubles.

Let it be assumed that the designer uses 130 lb. per square inch against 90 for the two-stroke-cycle double-acting type; at four times the revolutions per minute the gain in output would be directly proportional to the

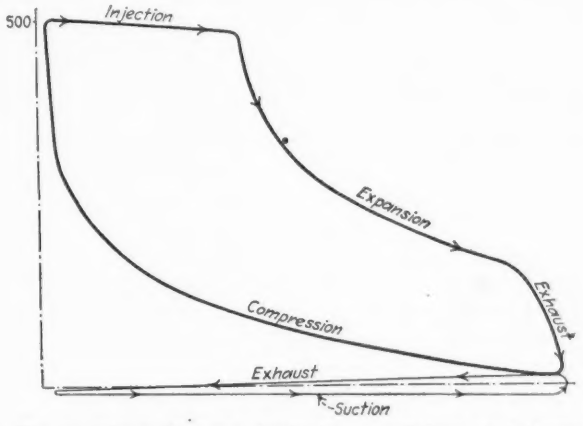



**Fig. 1—Diesel diagram obtainable if sufficient air is present**

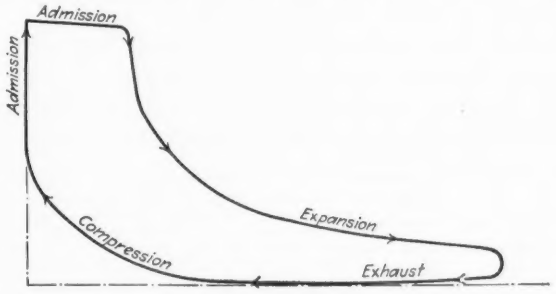



**Fig. 2—The long steam-admission period gives a high starting torque**

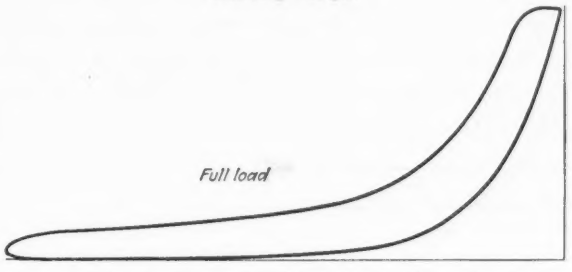



**Fig. 3—The theoretical diesel diagram**

gain in mean effective pressure, 40 per cent, but heat troubles due to increased density of the working gases would not follow such a simple numerical relationship and would be much greater. And increased heat stresses are more difficult to cope with in the four-stroke-cycle single-acting engine due to the complicated cylinder-head casting, which must embody several valves and valve cages, as against the plain, smooth two-stroke-cycle heads and cylinder liners which merely accommodate ports instead of valves.

All other values being the same in the comparison of a four-stroke-cycle single-acting engine at 130 lb. mean effective pressure and a two-stroke-cycle double-acting at only 90 lb. mean effective pressure, the two-stroke-cycle double-acting engine will develop 132 per cent more than will the four-stroke-cycle single-acting, with advantages in favor of the former of continuity of torque, lower inertia forces, longer life and less maintenance resulting from the two-cycle principle and the much lower mean effective pressure.

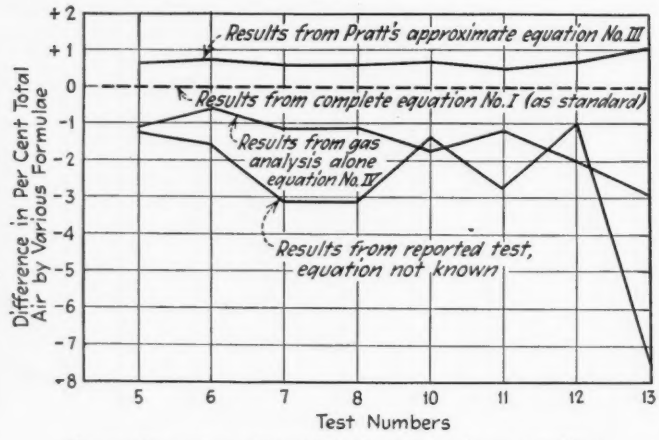
▼

# Calculations of Excess Air

ALL METHODS for determining specific losses incurred in boiler operation presuppose an accurate flue gas analysis for calculating excess air. Since the largest single loss is usually that of sensible heat in the products of combustion, the accuracy of the final results often depends upon the accuracy with which the total gas flow per pound of fuel is determined.

For exact determinations where complete analysis of the gas and ultimate analysis of the fuel are available equations 1, 1A and 2 are complete formulas that will give the true fraction of excess air. Equation 1 is used when there is combustible in the refuse, and when there is no sifting of coal from the stoker. Equation 1A takes into consideration the sifting that may be encountered, such as in the case of chain-grate stokers. Equation 2 is for the condition of zero combustible in the refuse, such as may be encountered when using pulverized coal. Equation 3 is for similar conditions, but is an approximate formula taken from page 57 of "Principles of Combustion," by Pratt.

All of the above equations require the ultimate analysis of the fuel burned. Frequently, for the setting of boiler meters, informal checks on boiler operation and other approximate work such ultimate analyses are not available. Under such conditions reasonable estimates of the probable excess air may be made from the gas analysis alone by using equation 4. In these equations $CO_2$, $CO$, $O_2$ and $N$ represent the per cent by volume of the constituents of the flue gas as determined by Orsat analysis;




**Comparison of results obtained with various equations**

**EQUATIONS FOR EXCESS AIR**

(1)
$$\frac{\left(\frac{11CO_2+8O_2+7(CO+N_2)}{3(CO_2+CO)}\right)\times\left(\frac{C}{100}+\frac{S}{183.3}-Ca\right)+\left(\frac{9H}{100}-\frac{100-Rd}{100}\right)}{0.1152(C-100Ca)+0.3456\left(H-\frac{O}{8}\right)+0.0432S}-1$$

(1A)
$$\frac{\left(\frac{11CO_2+8O_2+7(CO+N_2)}{3(CO_2+CO)}\right)\times\left(\frac{C}{100}+\frac{S}{183.3}-Ca-Cs\right)+\left(\frac{9H}{100}-\frac{100-Rd}{100}\right)}{0.1152\left(C-100(Ca+Cs)\right)+0.3456\left(H-\frac{O}{8}\right)+0.0432S}-1$$

2
$$\frac{\left(\frac{11CO_2+8O_2+7(CO+N_2)}{3(CO_2+CO)}\right)\times\left(\frac{C}{100}+\frac{S}{183.3}\right)+\left(\frac{9H}{100}-\frac{100-A}{100}\right)}{0.1152C+0.3456\left(H-\frac{O}{8}\right)+0.0432S}-1$$

3
$$\frac{\frac{3.036N_2}{CO_2+CO}\times\left(C+\frac{S}{2.667}\right)\frac{1}{100}}{0.1152C+0.3456\left(H-\frac{O}{8}\right)+0.0432S}-1$$

4
$$\frac{N_2}{N_2-3.78O_2}-1$$

SUMMARY OF DATA OBTAINED FROM SERIAL REPORT OF PRIME MOVER'S COMMITTEE REPORT, APRIL, 1927

| Test No. | 5 | 6 | 7 | 8 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|
| Coal Ultimate | | | | | | | | |
| Carbon | 80.89 | 80.99 | 82.12 | 81.19 | 80.96 | 81.02 | 81.58 | 79.98 |
| Hydrogen | 4.86 | 4.78 | 4.64 | 4.81 | 4.79 | 4.90 | 4.74 | 4.89 |
| Oxygen | 3.80 | 3.63 | 3.23 | 3.32 | 4.56 | 3.98 | 3.62 | 3.80 |
| Sulphur | 0.91 | 0.78 | 0.78 | 1.04 | 0.60 | 0.97 | 0.64 | 1.16 |
| Flue Gas | | | | | | | | |
| $CO_2$ | 15.12 | 14.48 | 15.25 | 15.69 | 14.44 | 15.14 | 14.06 | 15.53 |
| $O_2$ | 3.600 | 4.407 | 3.554 | 2.842 | 4.380 | 3.585 | 4.787 | 2.804 |
| CO | .053 | .053 | .027 | .021 | .020 | .010 | .010 | .033 |
| $N_2$ | 81.227 | 81.060 | 81.169 | 81.447 | 81.160 | 81.265 | 81.143 | 81.633 |
| Refuse | | | | | | | | |
| Per cent combustible | 3.84 | 3.54 | 3.98 | 3.63 | 4.46 | 4.20 | 3.60 | 11.39 |
| Refuse per cent dry | 8.28 | 8.45 | 7.90 | 8.32 | 7.87 | 7.86 | 8.12 | 9.70 |
| Total air, per cent | | | | | | | | |
| Equation No. I | 121.2 | 126.4 | 120.9 | 117.2 | 127.4 | 121.3 | 130.8 | 117.9 |
| Equation No. III | 121.9 | 127.2 | 121.5 | 117.8 | 128.1 | 121.7 | 131.4 | 119.0 |
| No. IV | 120.1 | 125.9 | 119.8 | 115.2 | 125.6 | 120.0 | 128.7 | 114.9 |
| Reported results | 119.93 | 124.92 | 117.78 | 113.00 | 126.07 | 118.47 | 129.79 | 110.35 |

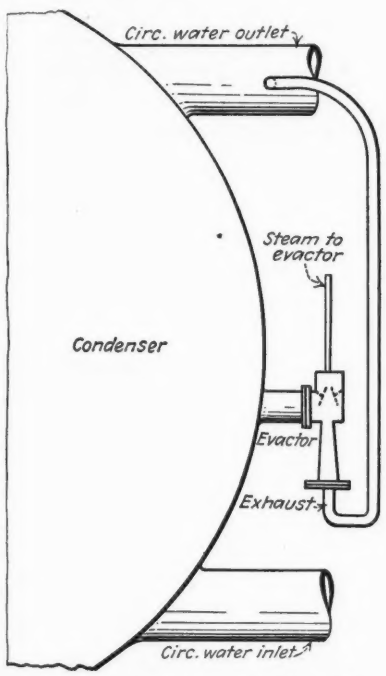
$C$ is the per cent carbon, $S$ the per cent sulphur, $H$ the per cent hydrogen, $O$ the per cent oxygen, and $A$ the per cent ash in the dry fuel by weight; $Ca$ is the combustible actually in dry refuse per pound of dry coal, $R_D$ is the per cent refuse actually obtained from dry fuel by weight, and $C_S$ is the pounds of combustible in the sifting per pound of dry coal.

To compare the per cent excess air as determined by these equations, data were selected from boiler tests given in the 1926-1927 Prime Movers Report on Boilers, Superheaters and Economizers. The data and the per cent excess air determined from the equation are given in the table, and the difference between these results, using equation 1 as standard, is shown by the curves in the figure. The results point clearly to the folly of reporting excess air values to the second decimal place (accuracy of one point in 12,000) when the formulas from which the results are calculated do not agree closer than plus or minus 3 per cent in the average, and 7½ per cent in an extreme case. The gas analysis for these tests were reported to 0.001 per cent, an implied accuracy of one part in 15,000.

# PRACTICAL AIDS TO OPERATION

## How Steam Consumption of Air Evactor Was Reduced

THE WORK done, and hence the steam required, by the air evactor on a surface condenser depends on the quantity of non-condensable gases to be exhausted and on the difference in pressure between the condenser vacuum and the evactor discharge pressure, which is usually atmospheric. The quantity of gases to be discharged cannot be decreased appreciably beyond a certain point. Since there is little chance of reducing the amount of vapor to be removed, the only possibility of reducing the steam consumption of the air evactor is to reduce the evactor discharge pressure. This can be done, in many cases, easily by piping the discharge to the circulating-water outlet, as shown in the accompanying diagram.




**Exhaust of air ejector connected to circulating-water discharge**

A vacuum of 10 to 20 in. of mercury, due to head and water velocity, usually exists at the point of connection as shown if its height is 10 to 20 ft. above the circulating-water discharge to tide-water or river level. The circulating water pump must, of course, operate in the inlet side of the condenser, because if not the condenser will lose its water or the pump will become air-bound. If the circulating-water outlet from the condenser is the bottom pipe, instead of the top, the vacuum at the point of connection will be less, but will still be enough to effect a saving in air ejector steam consumption. If the evactor is equipped with a condenser or cooler it is necessary to connect a trap at a low point in the piping to collect the condensed steam.

This system has been in service for several years in a plant with which I am familiar with considerable saving in steam consumption. Being such a simple layout, there are undoubtedly many plants where advantage could be taken of this arrangement.

Astoria, N. Y. GORDON R. HAHN.

## How Gas-Engine-Driven Units Were Made To Operate in Parallel

SPEED REGULATION of two duplicate 75-hp. direct-connected gas engines was for years unsatisfactory when attempt was made to operate them in parallel. Efforts by various operators to adjust the governors was simply a matter of cut and try. To enumerate here the amount of time spent and various ideas advanced as to what was wrong is unnecessary, inasmuch as in due time a practical operator came on the job who solved the trouble satisfactorily. He was of the opinion that the inability of the governing devices to function properly was not the cause of the poor speed and hunting when the machines were connected to the same bus.

As a tryout he removed a 2-in. pipe elbow located about 6 in. from the cylinder on the gas line to the engines and put a tee in its place. Into the outlet of the tee he screwed a short nipple and connected to this a piece of inner tube of an auto tire about eighteen inches long. The effect of this attachment was that upon each suction stroke of the piston the rubber tube would contract to about half its size—allowing the right volume of gas to enter the engine—without constriction. The immediate result was almost perfect operation.

Silverton, Colo. HAMMOND MATHEWS.

## Cutting Stand-By Plant Operating Costs

WITH THE increasing number of interconnections and the extension of transmission lines, more and more of the smaller plants are being shut down. As a rule these plants are being placed either on a cold or hot stand-by service, depending on the stability of the system and the characteristics of the territory served.

With economic conditions as they are, most companies are interested in every saving that can be effected in these plants, especially since they contribute little or no power to the system and serve only as insurance of continuity of service.

In one plant with which I am familiar quite a reduction has been made in the operating expense. It is required that this plant maintain hot stand-by service for a small capacity at least, to furnish steam to a near-by laundry as well as to maintain sufficient steam to operate the steam-driven spare city-water pumps in case of motor trouble or interruption to service. Of course, this service is also demanded in order that the generating station may be put into operation with the least loss of time.

When the economy program went into effect in the plant is was first found that a substantial reduction in the operating crew could be made. Fortunately, these men were able to be transferred elsewhere in the company.

The three turbine-generators in the plant are served by a 10-in. steam header. With a few changes it was found that the auxiliary city-water pump turbine and steam laundry supply could be fed from either of the two smallest boilers through a 2½-in. header. Accordingly, the larger header was cut out of service. The main header valve is easily accessible and requires only a short time to open. It is also equipped with a small bypass equalizing line to increase the safety in opening the large steam valve.

Cutting out of this line eliminated all radiation losses

as well as possibilities of leaks, and a considerable saving was effected. The two smallest boilers of the plant were piped with the small steam header, while the four larger boilers were not changed in the least.

The question of firing next came up. Experience went against intermittent firing to maintain pressure. It was found that a saving could be made with a small yet constant fire maintained.

Here arose another question. With such a small fire maintained in the furnace of this boiler designed for a much higher rating, inefficient combustion resulted. The relatively cool walls of the furnace did anything but aid the combustion. Having only 2,500 sq.ft. of heating surface, each of the two boilers was fired with one steam-atomizing oil burner. This same method was followed except for the fact that a burner with a much smaller oil slot was installed.

Then starting at the front wall inside of the furnace a wall of firebrick was built on each side of the burner. These walls were only about three feet apart at the burner and diverged toward the rear of the furnace. They extended the full length of the flame and were sufficiently high to retain the flame. Of course, the top and back between these walls was not covered. All in all, it amounted to a furnace within a furnace. These retaining walls, of course, remained hot during the firing period and aided greatly in increasing the efficiency of combustion.

The boiler-feed water had previously been fed to the boilers by a group of three turbine-driven pumps. Any one of these pumps was large enough to handle almost any combination of boilers. Naturally, they were much larger than was desired on either of these two smaller boilers; therefore, injectors were installed on these two boilers and have worked very well.

By still closer maintenance on all steam lines, checking insulation and operating the smallest available fuel oil pump, still further economies were effected. In fact, with this combination of changes, the fuel consumed was reduced to one-third of the original value and the investment in these changes was small.

Beaumont, Texas. R. F. SORRELLS.

## Easy Method of Making Orifices

THERE ARE a number of services in power plants and industrial steam plants where a pressure reduction is desired in steam, air, water or gas lines. If the requirements are such that the lower pressure need not be accurately maintained within close limits, the best method for the pressure reduction will be by an orifice.

For such services there are two simple but practical ways of constructing these orifices. For comparatively low pressure differential across the orifice and with low-temperature gas, water or air, an ordinary close nipple of the desired pipe diameter is poured full of lead. This nipple is then centered in a lathe or drill press and a small hole of the required diameter is drilled through the lead on the axis. The nipple is then screwed into the pipe line where the pressure reduction is desired.

For high-temperature fluids (steam) or for a greater pressure differential where a considerable cutting tendency is present the orifice is constructed in a different manner, but with equal simplicity. A piece of low-carbon steel round stock of the same diameter as the outside pipe diameter and same length as the nipple is centered in a lathe and the orifice hole drilled through. A pipe thread is turned on each end and the "nipple" is then screwed into position in the pipe line. An orifice of the latter type has given about six months' service with water at 300 deg. F., reducing it from 650 lb. gage to about 50 lb. pressure before any undue enlargement of the hole occurred. HARRY M. SPRING.

Boston, Mass.

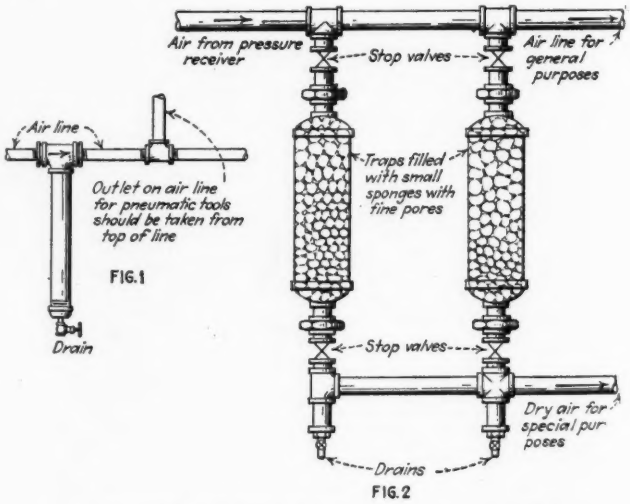
## Unique Moisture Trap for Compressed-Air Lines

IT IS CUSTOMARY to install moisture traps in the discharge lines of air compressors. According to the standards of the Compressed Air Society, good results can be obtained with moisture traps made up of pipe fittings consisting of tees set in the pipe lines at frequent intervals, the tees having a pipe leg hanging down to a drain connected at the bottom.

The tee and drop leg should be made of fittings several sizes larger than the pipe line. Fig. 1 shows the design according to the foregoing standards.

There are, however, compressed-air systems where no traces of either water or oil are permitted in the discharge air. This is particularly the case when compressed air is used for spray guns and the like. Moisture traps of conventional design do not always suffice for such installations.

Good results are obtained in a plant where a moisture trap is used consisting of a pipe full of sponges, as shown in Fig. 2. Two traps are connected in parallel,




**Conventional type of moisture separator and sponge-filled traps**

so that there is always one in operation while the other one is being cleaned. The sponges are removed from the traps periodically and thoroughly washed and dried before they are put back into service.

While standard traps have not given entire satisfaction, these sponge-filled traps have entirely overcome the difficulty of removing oil and water.

Sponge-filled air filters for the suction intake of air compressors are more or less commonly used for small machines, but it is unusual to apply the same type on the discharge line of a compressed-air system.

Galt, Ont. ERNEST L. MAAG.

# CURRENT COMMENT

## Engineers and the Machine World

No ENGINEERS have responded, so far, to your editorial of February 9. Evidently the engineer's part in leadership is not a talking one. A question arises, however: Can we call upon the engineer to accept any personal responsibility for the present chaos?

Your editorial asks that engineers be leaders of our present scientific civilization in order that it may survive. Is it scientific, and does it deserve to survive? We are very much justified in doubting either. The adjuncts to our society are scientific products produced by engineers, but our society is as yet as far from scientific as ever, and hence our truly engineering mind cannot stoop to the things it imposes upon leadership.

The writer has reviewed the leading magazine thought for the past eighteen months on the solution of the present problem. It involved weeks of reading. Did the average writer see an inch beyond his nose during the past two years? You answer it. Did any reputable engineers offer any suggestion? They did not. The engineer refuses to place himself in the position of the politician and produce a rabbit from the hat. Such a method frightens him; it insults him.

We may divide engineers into three classes. At the top are the great scientific minds who naturally take to research. Some of them are up against it now, but they could go hungry with better grace than a ditch digger and make less noise about it. They have produced our progress, if any, but they are not and cannot be held responsible for the so-called society now in pains and senility. They had no part in it, were not asked, nor permitted the authority. They made "suggestions," in most cases ignored.

A greater class is simply doing routine work, no more or less important than making blueprints, checking them against handbooks, adding up figures. They do, however, possess education of greater degree than their associates who rule the roost. This prevents any lasting understanding. Do they participate in getting the vote out? I should say not. Are they craving leadership and do you find them around the service clubs, ranting about the "government in business" one day and journeying to Washington the next to get their business exempted from the sales tax the next? On the other hand, they are the most indifferent appearing people who come under our observation. As a class they know less "what it is all about" than any other. It simply is not in their line.

There is another class, which we call the "kept engineer." He made some kind of figure for himself some place and has a prestige to sell, not ideas. He is supposed to be "consulting" or "researching" or something, but "kept" he nevertheless is, and admits it.

And does any one ask the engineer to sit in conference when the big idea, the deal, is being hatched? They do not. When the project has been projected, he is called in and given orders to certify it, work out somehow some sound reasons for another promotion. It makes little difference whether it is economically feasible or not. He is not asked to pass on his opinion of this very often.

Meanwhile, let us console ourselves the best we can. Let's not think about it more than we can help, but it is gradually leaking out all the time that in the quiet and peace of the study and the laboratory, he is working out new formulas, new products, new methods which are shortly to render obsolete what we are wont to call our "scientific civilization." This is where the engineer is functioning today, but little realized. A great deal, if not practically all of our present order, is destined to pass out, and a new order take its place.

This revolution will be so complete, and so different, we shall find fully as much difficulty in accustoming ourselves to it as we do now in trying to understand what happened to the old order. The soap-box type of leadership our engineers never will assume, but the kind of leadership he is capable of, the truly scientific, he goes quietly about even now—so quietly as to escape observation. ORVILLE ADAMS.

Dallas, Texas.

## Diesel Units for House Service

IN THE EDITORIAL in the April 5 number entitled "Diesel Units for House Service" there are certain statements with which I cannot fully agree.

To begin with, any house-service unit that is stand-by is of little value to a plant, due to the fact that when trouble develops which cuts off the house-service supply, interrupting the auxiliaries, one can be pretty sure the plant will be shut down, in which case there is no particular advantage in having a house unit that will have to be started up to get the plant going again.

A house unit is of value only when it is in constant operation either floating on the line, the auxiliaries being supplied by transformers from the main unit, or the house unit supplying all or part of the auxiliary current, in either case to be so connected and controlled as to cut in automatically and prevent loss of service to the station auxiliaries in case of trouble.

While it is true that the stand-by diesel unit does not have any stand-by losses when idle, it will require an auxiliary fuel supply, storage, pumping equipment, piping, cooling facilities, etc., which are all foreign to the modern steam plant using coal.

A diesel unit would, however, be a good type of unit for house service, due to its low operating economy independent of the rest of the station. It can be operated in parallel with a bank of transformers with suitable switching equipment, all arranged so that the diesel will carry the house-service load under normal operating conditions, the transformers to supply the peak load if necessary. But in any case, both the diesel and the transformer bank would have to be of sufficient capacity to handle all the auxiliaries whenever the occasion required.

House service with diesel sets would make it possible to have all direct-current auxliaries, thereby obtaining the benefits derived from the flexibility of speed control of direct-current motors. In this case, a spare unit would be necessary, or a motor generator set could take care of the auxiliary service in case of trouble or maintenance requirements of the diesel. M. Y. CURLEY.

Bay Shore, N. Y. Long Island Lighting Co.

# READERS' PROBLEMS

HIGH-PRESSURE BOILER FOR HEATING—*We shall shortly be required to erect a heating plant for a new building. The situation is such that two or three years from now it may be advisable to generate power as well as steam. Money for prime movers is not available at present. It has been suggested that, with future power generation in mind, we install a high-pressure boiler now instead of a low-pressure heating boiler. Would this be wise? If a high-pressure boiler is installed, should it be operated at high or low pressure?*

L.F.G.

By high-pressure boiler we assume you mean one of, say, 200 lb. pressure. First cost would be somewhat higher, but not enough, probably to rule it out. The high-pressure boiler used for heating could be operated at heating pressures or could supply heating steam through a reducing valve. Each method has its advantages. High-pressure operation would require a licensed operator (in most places) and greater care in inspection and operation. Efficiency would be somewhat lower due to higher temperature of the boiler water and hence of the flue gases. Steam for operating feed pumps and other auxiliaries would be available. High-pressure operation would require a high-pressure safety valve. If the high-pressure boiler were to be operated low-pressure it should preferably be equipped with a low-pressure safety valve. This would have to be replaced by a high-pressure valve when operation was later shifted to high pressure.

HEAT REMOVED IN COOLING AIR—*How much heat must I remove from 10,000 c.f.m. of air at 80 deg. F. and 50 per cent relative humidity in order to reduce its temperature to 70 deg. and its relative humidity to 40 per cent?*

G.C.

At the initial condition dry air has a density of 0.0735 lb. per cubic foot. Thus the weight of dry air to be cooled is 735 lb. a minute. The sensible heat to be removed is $735 \times 0.24 \times 10 =$ 1,764 B.t.u. per minute, where 0.24 is the specific heat of dry air.

At 80 deg. F. and 50 per cent relative humidity the dew point is 60 deg. and the air contains 0.011 lb. of water vapor per pound. At the final condition the dew point temperature is 45 deg. and the air contains 0.00628 lb. of water vapor per pound. From steam tables the total specific heat in the water vapor at the initial condition is 1,093.9 B.t.u. and at the final condition 1,090.2 B.t.u. The heat to be removed to reduce the relative humidity is $(0.011 \times 1{,}093.9) - (0.00628 \times 1{,}090.2) = 5.19$ B.t.u. per pound of air, and $5.14 \times 735 =$ 3,814 B.t.u. per minute for the total quantity.

The total heat to be removed is the sum of the sensible heat and that required to reduce humidity, or 1,764 + 3,814 = 5,578 B.t.u. per minute.

This is the difference between the total heat in the air at initial and final conditions. To reach the final air condition it would be necessary to cool the air to 45 deg. and then reheat to 70 deg. This would, of course, require the removal of more heat than 5,578 B.t.u.

The amount of actual refrigeration needed can be decreased by cooling part of the air to a slightly lower temperature and subsequently mixing it with air that has bypassed the air coolers. Another method of reducing the humidity is to use such chemicals as silica gel or calcium chloride.

▼ ▼ ▼

# Polyphase Motors Can Be Protected Against Single-Phase Operation

*IT HAS always been a serious problem in our plant to prevent the three-phase motors operating single-phase. These motors are in many cases protected by fuses only. I should like to hear how other operating engineers are handling this problem and what they consider the best way to check the fuses.* R.C.M.

TO PREVENT three-phase motors operating single-phase has always been a problem and if not taken care of properly may cause severe overheating of windings. I have found that the best protection is to install some sort of thermal overload device in every motor circuit. For motors that are started by an ordinary switch a reliable and inexpensive method is to install thermal plugs in motor leads between switch and motor. These plugs should not have a rating of over 125 per cent of the motor full-load amperes.

For larger motors, usually started by compensators equipped with undervoltage protection, I suggest thermal overload relays connected between compensator and the motor unless the starting load is very heavy. In the latter case it is necessary to connect the relays between the disconnecting switch and compensator to prevent the heavy starting current from tripping the relays set for 125 per cent of the motor's rating. In either case the control relay's contacts should be connected in series with the undervoltage coil of the compensator.

This apparatus will serve two purposes: First, it will give overload protection, and, second, it will prevent continuous single-phase operation when one fuse is blown. Thermal relays I have found to be reliable and to give protection that is impossible with regular fuses. GEO. D. NOILES.

Hudson, Mass.

## Recommends Open-Phase Relays

FOR MOTORS requiring currents of from 5 to 300 amp. open-phase and phase-reversal relays may be used with magnetic controller, to provide protection for polyphase induction motors against open phase and phase reversal. Under normal conditions and also when de-energized the control circuit contacts on the relays are closed. When a phase becomes open or reversed, the relay opens the control circuit of the magnetic controller and stops the motor. The control contact on the relays is hand reset.

Under no condition will the motor start or attempt to start if one phase is open. This is also true if the phase rotation is reversed, or if one phase is unbalanced to the extent that the current in one pair of relay coils becomes approximately three times that in the other pair. These phase-failure relays serve as a good check on the fuses. For over 300-amp. loads, series transformers are used with the relay. We have used over 200 of these relays in our plant and they all have given good results. HAROLD J. AGATE.

Buffalo, N. Y.

## Uses Indicating Lamps

BLOWN FUSES in a three-phase motor circuit can be easily detected with a voltmeter. The voltage on each end of the fuses should be the same. For example, in Fig. 1 assume that the voltages across *AC*, *CE* and *AE* are 220, 219 and 218, respectively. When the voltmeter is connected to terminals *BD* the voltage should be practically the same as when connected to *AC*, or 220. Similarly, about 219 volts, that across *CE*, should be obtained at *DF* and the volts across *BF* should equal *AE*, or

218. If the voltage on the load side of the fuses is materially different from that on the line side it is a good indication that a fuse is blown.

The foregoing is on the assumption that the power lines are intact to the motor switch. If the voltage is found to be considerably out of balance at both the line and load ends of the fuses it is an indication that a fuse is blown on the feeder, and a test should be made at the next set of fuses back on the line.

A blown fuse on a three-phase-motor circuit with the motor running will have about 10 per cent of the rated voltage of the line across its terminals. For instance, if fuse *AB*, Fig. 1, were open and the normal line volts was 220, then a voltmeter connected from *A* to *B* would indicate a potential difference of about 20 volts. Advantage has been taken of this potential difference to illuminate indicating lamps. The lamps

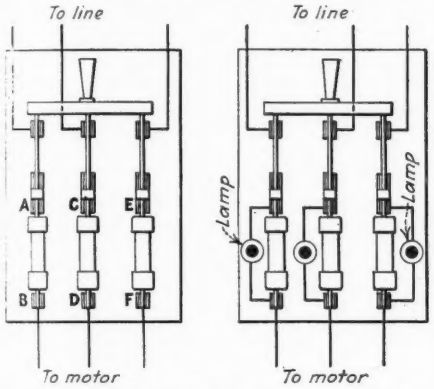



**Fig. 1—(Left)—Three-pole fused switch**
**Fig. 2 (Right)—Indicating lamps on fuses**

are connected as in Fig. 2. If the fuse blows, the lamp connected to its terminals will light. Red lamps are generally used, and although the voltage across the terminals of a blown fuse may be only 20 to 40 volts, depending on the line volts, it is enough to cause a tungsten lamp to glow sufficiently to give a clear indication of the open fuse.

Philadelphia, Pa. M. R. WILSON.

## Tests Fuses With a Piece of Wire

WE HAVE experienced somewhat the same trouble in our plant with some 110-volt 3-phase motors. Until we discovered the cause for blowing our main supply fuses a periodic test was made to detect blown fuses. The test was a simple one. A piece of insulated wire was jumped across each fuse between the upper and lower fuse clips. When a blown fuse was bridged considerable sparking occurred at the jumper terminals when making the breaking contact. If the fuse was intact there was no sparking.

I see no reason why this principle cannot be applied to circuits of higher voltage and greater capacity by inserting a protective fuse in the jumper to limit this sparking to a safe amount. The jumper, when placed across a blown fuse, would spark at the terminals and possibly blow its own fuse. If there was no sparking and the jumper fuse did not open it would indicate that the fuse being tested was intact. An indicating fuse could be used for this jumper if found more convenient.

The rated voltage of this fuse should be equal to or greater than the fuses to be tested. The ampere rating could be chosen by trial, being just large enough to provide visible sparking at the jumper terminals. J. N. EWART.

Buffalo, N. Y.

## Thermal Overload Protection

FUSES FORM, at best, an unsatisfactory protection for alternating-current motors. If the fuse rating is low enough to protect the motor properly, they generally will give trouble when starting. When motors are protected only with fuses it is common to find that operators have installed fuses of a rating just sufficient to carry the starting current without blowing. These fuses will gradually deteriorate until one of them will melt, not necessarily during a period of maximum load. Such fuses not only give trouble due to deterioration, but they give no real overload protection to the motor.

To protect the motors against single-phase operation install some form of thermal overload protection, or, in the case of large motor, use time-delay overload relays. There are many makes of thermal overload protection devices on the market. In general these devices consist of a heater which carries all, or a proportion, of the motor-load current, the heater having a time-temperature characteristic similar to that of the motor to be protected. A large overload will cause rapid heating, and a small overload will cause gradual heating, as is the case in the motor itself.

Thermal overload protective plugs can be adapted for use with existing small motor-starting switches. All that is necessary is to specify the motor horsepower and voltage, or to specify the normal full-load motor current.

An interesting example of the type of protection afforded by this arrangement was given a year or two back in a plant where a number of one-horsepower motors were operating on one circuit. Each motor was individually protected with thermal overload cutouts, and the circuit supplying all the motors was protected with fuses. One motor broke down in one phase to ground, thereby blowing one line fuse. At the same time the overload protection on this motor operated, but the other motors on the circuit were left running single-phase. The current in the single operating phase was greater than the normal current rating of the protective device, and the other motors began dropping off the line one after another at periods depending upon the load on each individual machine. As soon as the motors began to stop the shift electrician realized that they were probably running single-phase. A check of the circuit fuses cleared up the situation.

C. E. OLIVE.

Drummondville, Que.

## A Question for Our Readers

WE HAVE SEVERAL PUMPS *in out plant. On three or four occasions a pump has run dry end has been damaged before the cause of the trouble was detected. In each case the trouble has been caused by an obstruction lodging in the suction pipe. It may be that some reader can tell me of a way to cause the pump's motor to stop automatically when the suction pipe becomes stopped up and the pump starts to run dry.* O.F.R.

Suitable answers from readers if received promptly, will be paid for when published. Typewritten replies should preferably be double spaced.

## Blown Fuses Detected by Their Temperature

THE FIRST thing for R. C. M. to determine is why the feeder fuses fail. The theory of protection is that the fuses nearest a fault should open first. Motor fuses should clear the motor when there is trouble on this equipment. Feeder fuses should blow only when there is actual trouble in the line or when any of the smaller protective devices have failed due to a flashover. Thus the failure of feeder fuses should be preceded by an event which will lead to an investigation to determine the fault.

Blown fuses may easily be detected as the temperature of fuses carrying near rated current will be above normal and when open a fuse will be cool. Feeders in single-phase operation may easily be detected by the unbalanced voltage and currents. The use of a split-core current transformer and ammeter directly in back of the fuses will quickly tell conditions in the cable. The power factor will be lower than normal. Motors operating single-phase and at near rated load will be hotter than usual.

Feeders will carry heavy overloads for short periods and do so when motors and transformers are put into service. They should then be fused above their rated capacity and a periodic check made to keep loads properly distributed. Feeders will practically never give any trouble when properly designed and fused. One feature which should be watched is that the fuse clips do not become dirty and loose, to cause local heating and thus blow the fuses.

Salem, Mass. PUTNAM CILLEY.

# THE ENGINEER'S BO

## "Scarcity Concept" Obsolete

THE PARADOX OF PLENTY. *By Harper Leech, with an introduction by Virgil Jordan. Published by Whittlesey House, McGraw-Hill Book Company, 330 West 42nd St., New York City; 1932. Cloth, 5½x8½ in.; 208 pages. Price, $2.50.*

GIANT CITIES will grow no larger and will lose their present financial and industrial importance; industry will break up into smaller units and operate in what are now rural districts; and the worker will receive a greater share of his employer's profits in order to maintain buying power, all in the comparatively near future, and because mankind has discarded human and animal energy based on food cultivation and substituted for it his newly discovered ability to convert solar energy into work, principally in the form of electric power. These are some of the predictions affecting the welfare of humanity made by Harper Leech, writer on economic subjects, in "The Paradox of Plenty."

That "this is not a depression but a mishandling of the greatest era of plenty the world has ever known," is the thesis of Mr. Leech's book. "The plain fact is," he says in his preface, "that after thousands, perhaps millions, of years of living on the energy grudgingly tendered by the sun through annual harvests of crops, man suddenly became aware that the same sun had been storing energy for millions of years. He discovered in coal an energy store with millions of times the energy available from his own muscles. Nearly two hundred years later, he still thinks of 'scarcity' when there is no scarcity. And, failing to adjust his institutions and his financial mechanisms to the conditions of plenty, he has failed to realize the advantages of plenty."

Mr. Leech points out that the vastly increased ability to produce agricultural and other products that electrical energy has placed in the hands of men has destroyed completely the premise that scarcity is a measure of value. With the energy now available, he says, it takes but a small proportion of the population to supply the essential needs of the whole nation. Therefore, he adds, there can be no scarcity, and scarcity ceases to be a measure of value. "We will continue to value things by their scarcity for some time to come," Mr. Leech continues, "but to maintain the semblance of old values and to sustain the system of exchange based on price we will have to produce artificial scarcity, or inflate prices by cheapening money and expanding bank credit."

The transformation of the United States into a new form of industrial society, through the interconnection of electric power and transmission of energy, has already started, according to Mr. Leech, and "is now proceeding as rapidly as the previous political and economic integration of America by railroad construction." As an example of what may be expected of the future industrialism, he cites recent developments in the Piedmont region of the Carolinas, where the shift from agriculture and cottage industries has not been accompanied by the growth of mammoth, unwieldy cities. In answer to critics of this trend he writes:

"The more clearly it is recognized that wealth and income are the results of the accessibility and efficient use of energy, the more will the mind of modern mankind become convinced of the economic absurdity of the modern city."

Without exception this book should be on the required reading list of all engineers, executives and bankers.

## What Industry Thinks

ECONOMIC ATTITUDES IN INDUSTRY. *By F. C. Caldwell, C. A. Norman and John Younger. Published as Circular No. 26 of the Engineering Experiment Station, Ohio State University, Columbus, Ohio; 1932. Paper, 6x9 in.; 24 pages. Free.*

FIFTEEN QUESTIONS having to do with fundamental problems and policies in American industries were put to 400 industrial leaders and 45 economists by the authors of this pamphlet, which is an analysis of the replies received.

There was noted among those answering a distinct desire to rationalize industrial processes and the feeling was preponderant that by such rationalization a fair degree of well-being and comfort can be secured for all citizens. As to methods and agencies of rationalization there was, however, a great diversity of opinions. Business leaders in general do not favor much government interference, except perhaps in national emergencies, but among economists there is a large group who believe that only through government guidance, and in some cases even government ownership, can real rationalization be brought about.

On the other hand such things as old-age pensions, shortening of the working day and working week, and even unemployment insurance find a surprisingly widespread support among industrial leaders, and there seems to be little hesitation to admit that labor organizations could furnish distinct aid in rationalization.

There is almost unanimous emphasis on the need for more cultural training and a wider social outlook among industrial executives, and numerous suggestions are given as to topics of study which would help engineering students to gain these qualifications.

## New Engineering Handbook

GENERAL ENGINEERING HANDBOOK. *Edited by Charles Edward O'Rourke, assistant professor of structural engineering, Cornell University. Published by the McGraw-Hill Book Company, 330 West 42nd St., New York City; 1932. Semi-flexible binding, 5x8 in.; 921 pages; diagrams, charts and tables. Price, $4.*

NO MATTER what specialty he pursues, the average engineer is often confronted with a need for specific information in some other branch of engineering. At such times he will find this new general engineering handbook of immense value. For here he will find definite methods and facts covering all of the main subdivisions of civil, mechanical and electrical work.

The material in the book is conveniently arranged in 31 sections of varying length, each section dealing with one general subject. Six of these sections contain matter of importance to all engineers; eleven belong primarily in the field of civil engineering, nine in mechanical engineering and five in electrical engineering.

Among the subjects covered are mathematics, engineering materials, graphic statics, various types of structures and foundations, highways, waterpower plants, water supply and sewage disposal, machine elements, heat and thermodynamics, steam power plant equipment, internal combustion engines, pumps and compressors, heating and ventilating, refrigeration, welding, mechanical power transmission, electricity and magnetism, electrical measurements and machinery, electric power equipment, transmission and distribution.

## Diesel Engine Progress

DIESELMASCHINEN V. *Special edition of the V.D.I.-Zeitschrift published by the V.D.I.-Verlag, Dorotheenstr. 40, Berlin NW. 7, Germany; 1931. Paper 9x12 in.; 158 pages; illustrations, charts and tables. Price, 7.50 marks.*

IT HAS BEEN often asserted that development of the diesel engine has come to a conclusion, but just as often designers and makers set such predictions at naught. Especially during the last years development has proceeded beyond expectation. All concerned will therefore welcome this publication, which contains everything new in the sphere of recent diesel engine construction.

This special edition, like the preceding ones, includes the most important

# BOOKSHELF

publications on diesel engines which have appeared in the *V.D.I.-Journal*, together with others that have not been published before. Among the latter are the papers read before the sectional meeting on "International-Combustion Engines" at the 70th annual convention of the Verein deutscher Ingenieure, as well as some other important publications.

It is not possible to give here a detailed account of the many-sided contents of the 37 articles. Latest developments in diesel engines are characterized by increase of output per cylinder unit, the construction of marine engines of high output and the construction of locomotive and car engines. Six articles are devoted to automobile engines, two to diesel locomotives and three to marine engines. Other contributions deal with thermodynamical researches, investigations on the operation of engines and on fuel injection with accessories and individual parts.

## Electrical Code Explained

NATIONAL ELECTRICAL CODE HANDBOOK. *By Arthur L. Abbott. Published by the McGraw-Hill Book Company, 330 West 42nd St., New York City; 1932. Cloth, 5x7½ in.; 473 pages, illustrations and tables. Price, $3.*

THE STANDARD of wiring for power and lighting and other circuits in the United States is the National Electrical Code. Although a great deal of effort has been devoted to making this code easily understood, engineers and electrical workers not infrequently find it difficult to apply the code regulations to specific sets of conditions. In this handbook the purpose is to enable the reader to grasp readily the general plan and intent of the code requirements. Detailed discussion of the rules are given where something of practical value can be contributed and the practical application of the rules made clear and easily understood.

The treatment has been divided into five parts: Definitions of the terms used in the code; rules specifying what types of wiring are approved under given conditions; material and apparatus; general requirements applying to all wiring systems; and special cases. Many illustrations are used to show how to apply the various classes of materials in a way that will comply with the code rules.

The subjects of motor wiring and overload protection and grounding are ones about which there has been much misunderstanding. A chapter has been devoted to each of these subjects and many illustrations are used to show the several ways of applying protective devices and making ground connections. Numerous examples are given on how to calculate the size of wire for different types of loads and how to select protective equipment for these circuits. These and many other treatments make the book a valuable reference for all users of the code and as a textbook for individuals and classes making a systematic study of these regulations.

## Power Popularized

BEHEMOTH: THE STORY OF POWER. *By Eric Hodgins and F. Alexander Magoun. Published by Doubleday, Doran & Company, Garden City, N. Y.; 1932. Cloth, 6x9 in.; 354 pages, fully illustrated. Price, $3.50.*

WITH EVERYTHING from the dark archives of history to the philosophical heights of multi-dimensioned scientific theory being "humanized" and "popularized," it is not surprising that power should be a victim to the trend. But it is regrettable, because so few really well-balanced, comprehensive treatises on the subject are available.

Unfortunately, "Behemoth" is not one of these. It is, as the authors admit in a disclaimer, a "very unlearned book"—a sprightly humanization of the evolution of the machine age. With many witty, though sometimes inaccurate, sidelights on the engineers and inventors concerned, it dramatizes the history of power from muscles, wind and water to the present wonders of steam, electricity and the internal combustion engine.

Beautifully illustrated, the book makes highly entertaining reading, but it is not as thrilling and exciting as the jacket blurb would have you believe. In fact it is not as thrilling as Hugh and Margaret Vowles' "The Quest for Power," reviewed in these columns a few months ago, which still remains the best serious attempt to chronicle *the* story of power.

# BRIEF REVIEWS

PROCEEDINGS OF THE THIRD INTERNATIONAL CONFERENCE ON BITUMINOUS COAL. Two volumes published by the Carnegie Institue of Technology, Pittsburgh, Pa.; Vol. I—965 pages, Vol. II—1,034 pages; illustrations and tables. —Complete papers and discussions of the meeting reported in *Power* for Dec. 1, 1931.

UNTERSUCHUNGEN ÜBER DEN SCHMIERVORGANG IN GLEITLAGERN. By W. Nücker. Published by the V.D.I.-Verlag, Dorotheenstr, 40, Berlin NW.7, Germany; 84 pages, 9 tables; price 5 marks.—An investigation of the lubricating process in sleeve bearings.

SMOKE AND ITS PREVENTION. By H. M. Faust. Published as Circular No. 24 of the Engineering Experiment Station, Ohio State University, Columbus, Ohio; 15 pages, illustrated; free.—Explains several possible cures for smoke production in commercial and household heating plants. The illustrations show proper and improver methods of firing furnaces and the results obtained.

MANUAL OF ELECTRIC ARC WELDING. Edited by E. H. Hubert. Published by the McGraw-Hill Book Company, 330 West 42d St., New York City; 163 pages, 126 illustrations; price $2.—Sponsored by the Welding Section of the National Electrical Manufacturers Association, this book explains the fundamentals of arc-welding processes, gives practical suggestions on performing various welding operations and enumerates many useful applications of arc welding. Of particular interest to the prospective operator and to the executive who may wish to develop operators is a course of training exercises.

DIE WARMEUBERTRAGUNG BEI ZAHEN FLUSSIGKEITEN. By Dr. H. Braussold. Published by the V.D.I.-Verlag, Dorotheenstr. 40, Berlin NW. 7, Germany; 20 pages, 24 illustrations; price 5 marks —Results of an investigation of heat transfer in viscous liquids.

MECHANICAL WORLD ELECTRICAL POCKET BOOK, 1932. Compiled and published by Emmott & Company, Ltd., 65 King St., Manchester, England; 334 pages; diagrams and tables; price 1s. 6d. net.—Four new sections on electric welding and cutting, power plant operation, electric railways and lighting have been added to this useful handbook of practical electrical engineering.

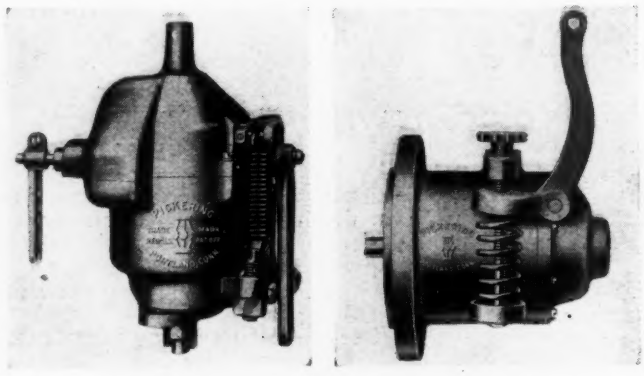
THE GASOLINE AUTOMOBILE. Fourth Edition. By Ben G. Elliott and Earl L. Consoliver. University of Wisconsin text published by the McGraw-Hill Book Company, 330 West 42nd St., New York City; 609 pages, 635 illustrations; price $3.—A complete revision of Hobbs, Elliott and Consoliver's well-known text of the same name, this book deals thoroughly with the fundamentals of automobile construction and maintenance. Special chapters on operation and troubles with their remedies should prove valuable to every one who runs or works with an automobile.

# WHAT'S NEW IN PLANT EQUIPMENT

## Governors for Internal-Combustion Engines

IN ADDITION to its standard line of steam governors, the Pickering Governor Company, Portland, Conn., is also making several new models for internal-combustion engines. The G. P. and G. P., Jr. models are illustrated.

Model G. P. is designed for vertical mounting, especially for gas engines of medium and large sizes, and has recently been adapted to use on some of the smaller diesels. With a wide governing range, it is said to give extremely close regulation at any set point. Equipped with ball bearings throughout, it has practically no wearing parts, and lubrication is accomplished either by splash or feed from the engine. The model illustrated shows provision for remote control where the engine is used for variable-speed conditions. Through simplified design, it may also be obtained for constant speed.



**Pickering Models GP and GP Jr. governors for internal-combustion engines**

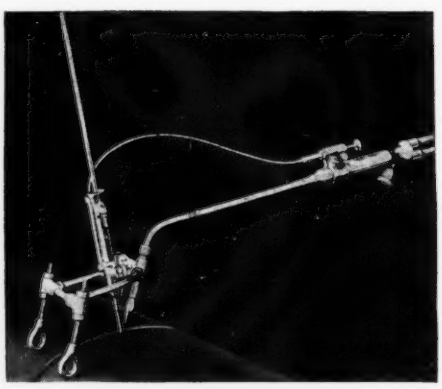
Model G. P., Jr., is designed for horizontal position, the usual mounting being on the timing-gear plate. This model is especially recommended for high-speed engines of smaller bore and stroke. It has an adjustable speed changer. It is also equipped with ball bearings and operates in a bath of oil.

## Welder Employs Two-Flame Blowpipe and Supporting Carriage

THE ILLUSTRATION shows the Oxweld Type W-21 Lindewelder put out by Linde Air Products Company, 30 East 42d St., New York City, in position on a pipe line. The welder is a two-flame blowpipe with a rod holder which feeds the welding rod automatically by gravity. A rod-lifting device controlled by a trigger on the blowpipe handle permits the operator to raise or lower the welding rod as required in starting and completing the weld, in passing over tack-welds and in changing the rod. A carriage having two adjustable runners supports the blowpipe during the welding operation.

Two separate flames are utilized, one for preheating the welding rod and one for performing the actual welding operation. The upper, or preheating, flame is so adjusted that the inner cone impinges directly on the rod as it emerges from the lower end of the rod holder, preheating it nearly to the melting point. The lower flame is the welding flame, which is directed between the vee and the rod so that it prepares the base metal for proper fusion with the weld metal and simultaneously melts the end of the preheated welding rod in the welding puddle.

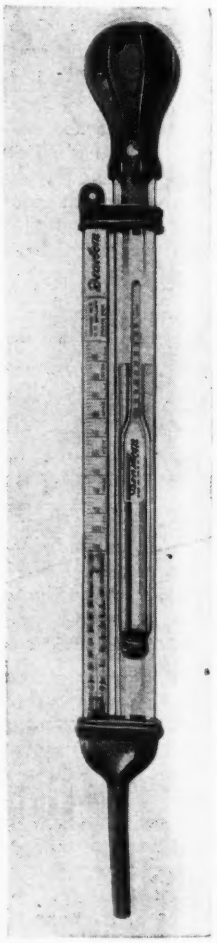
Five sizes of welding tips, Nos. 9 to 13, inclusive, and five sizes of preheating tips, Nos. 4 to 8, inclusive, are available. Interchangeable welding-rod holders are furnished in three sizes, for ¼-in., 5/16-in. and ⅜-in. welding rod. In operating position, the welder is supported by the carriage, with the runners straddling the weld directly behind the welding puddle. The runners can be adjusted in length and angle, making it possible to maintain the proper position for all types of work.



**Lindewelder in position on a pipe**

## Boiler Water Concentration Hydrometer

TO PROVIDE a rapid and convenient method for determining the total dissolved solids in boiler-feed water, the Dearborn Chemical Company, 310 South Michigan Ave., Chicago, Ill., has introduced the concentration hydrometer illustrated.



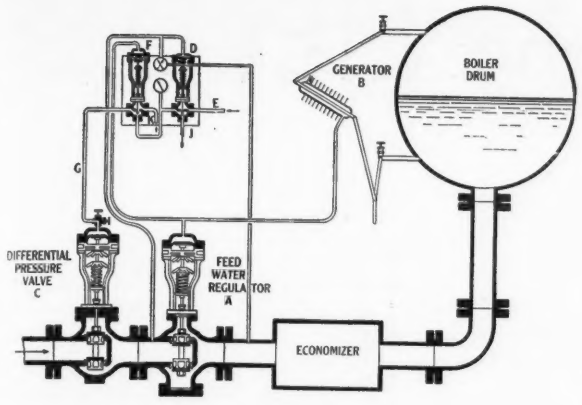
The manufacturers' instructions for using the hydrometer are as follows:

Have water sample at room temperature or from 60 to 120 deg. F. Draw water in instrument and expel two or three times to make sure the temperature of the glass is the same as the water. Draw sufficient water into the jar to float the hydrometer freely. Hold instrument in vertical position and read float scale as soon as hydrometer has come to rest. Read correction scale *B* (on the thermometer) and subtract *B* reading from float reading. Refer to this number in table built into the instrument for total dissolved solids concentration in grains per United States gallon.

The hydrometer has a concentration range from 0 to 1,100 grains per United States gallon.

## Feed-Water Regulator With Differential-Type Master Control

DESIGNED to embody the three fundamental requirements for smooth feed-water regulation, that of accurate response to changes in water level, exact control of the pressure drop




**S-C feed water regulator with differential type master control**

across the main feed-water regulator valve and provision for automatic bypassing of the differential pressure regulator when an emergency demands the feeding of sudden large volumes of water, the improved S-C regulator brought out by the Swartout Company, 18537 Eculid Ave., Cleveland, Ohio, makes use of a differential type master control which is essentially a pressure amplifier. Through the use of this control slight fluctuations in differential pressure are magnified and these enlarged fluctuations are in turn used to operate the differential pressure valve.

Referring to the illustration, *A* is a standard S-C feed-water regulator operated by generator *B*. The pressure drop across valve *A* is maintained constant by controlling valve *C*, which in turn is governed by the differential pressure master control valve *D*.

A source of operating-pressure steam, water or air ranging from 80 to 250 lb. is connected to valve *D* and passes through this valve and body of valve *F* to the diaphragm of valve *C*. As the two sides of the diaphragm of valve *D* are connected respectively to the inlet and outlet of regulating valve *A*, the net differential pressure across this valve is a moving force to actuate master control valve *D*.

Should the differential pressure across valve *A* rise, it causes the valve stem of valve *D* to move downward. This reduces the venting effect through pipe *J*, which increases the pressure passing through to valve *C*. This valve then closes slightly, bringing the differential across valve *A* to its proper value. If the differential pressure decreases the opposite action takes place.

The setting of master control valve *D* and differential control valve *C* is such that the lowest possible differential is maintained consistent with feeding the boiler under all normal loads.

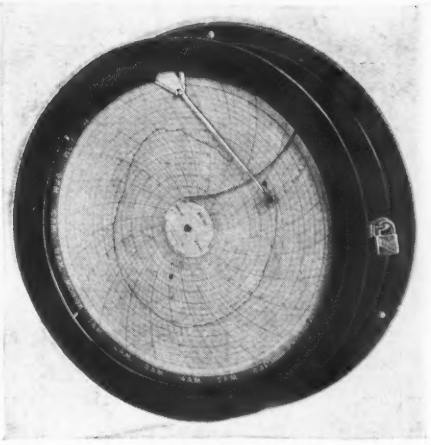
To provide for feeding the boiler under abnormally high load conditions a second master control valve *F* is interposed in the piping connection between master control valve *D* and the diaphragm of valve *C*. The diaphragm of valve *F* is connected to the same generator system as valve *A* and the springs are so adjusted on valve *F* that at all fluctuations in normal water level the stem of the valve will be at its highest position, leaving a free passage through the body for the pressure between valves *D* and *C*.

In the event that the water level in the boiler goes below the limit for which the regulator has been set, the increased generator pressure reacts upon the diaphragm of valve *F*, moving the stem downward and restricting the flow through pipe *G* to valve *C* and at the same time venting the pressure through pipe *K*. This starts to open valve *C* and this continues until the valve is wide open, giving full pump discharge pressure at valve *A*, which, owing to the increased pressure in the generator, is also in wide-open position.

## Absolute-Pressure Gage

IN DETERMINING the efficiency of a steam turbine and condenser it is necessary to know the amount of back pressure in the condenser. This quantity must be determined from a zero basis and requires the measurement of absolute pressure. To provide a ready means of determining this pressure without the necessity of subtracting the readings of a vacuum gage from the readings of a barometer, the Brown Instrument Company, 4496 Wayne Ave., Philadelphia, Pa., has introduced the absolute-pressure gage illustrated.

**Manometer transmitter used with absolute-pressure gage**



**Brown recording absolute-pressure gage**

A mercury-filled tube is employed in the new gage. A standard Brown manometer is used which, by an application of the electrical inductance bridge, converts changes in the relative level of the mercury columns into electrical impulses which in turn operate a pointer or recording penarm in the connected instrument to give the absolute-pressure reading.

The indicating or recording instrument may be at practically any distance from the manometer. The gage is made for service within a minimum range of 0 to 100 millimeters of mercury absolute pressure.

## New Electrode for Welding Aluminum

AN ELECTRODE for welding aluminum, to be known as "Aluminweld," is announced by the Lincoln Electric Company, 13034 Colt Road, Cleveland, Ohio. The new electrode is a 5 per cent silicon aluminum alloy and can be used for welding sheet or cast aluminum and is designed for either metallic or carbon arc welding.

It is provided with a coating which prevents excessive oxidation and will dissolve any aluminum oxide that might be formed. The manufacturers claim that the coating assists in giving a smooth operating arc and that the resulting weld is dense without porosity and possesses high tensile strength. The weld can also be polished satisfactorily with practically no discoloration. In its use a short arc of approximately 20 volts should be held with the coating practically in contact with the work.

Aluminweld is produced in four sizes, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$ and $\frac{3}{16}$ in. in 14-in. lengths.

# NEWS of the FIELD

## Fuel Competition, Plant Reconditioning and Stokers Discussed at Midwest Coal Conference

PRODUCERS, distributors and users of bituminous coal met at Purdue University, Lafayette, Ind., for a busy two-day session of the Fifth Annual Midwest Bituminous Coal Conference.

This conference, held on April 14 and 15, was sponsored by Purdue University and the University of Illinois with the cooperation of the Indiana Coal Trade Association and the Illinois Coal Bureau as well as the Illinois State Geological Survey. The annual meeting of the Indiana Branch of the National Association of Power Engineers was held in conjunction with this conference affording an excellent opportunity for the users of coal to meet and discuss their problems with coal producers and distributors as represented by members of the various coal associations. Total registration at the conference was 320.

The first session was presided over by Jonas Waffle, managing director of the Indiana Coal Trade Association. This session, devoted to industrial coal uses, was taken up principally with the competition of natural gas with Midwest coals, the two specific instances being in Iowa and Minnesota.

### Coal vs. Gas at Rochester

The first paper presented was a chronological report of the events concerned in the replacement of coal by natural gas in the municipal light plant at Rochester, Minn. This report dealt mainly with the events leading up to this replacement and the somewhat belated attempt of the coal industry to study and to present their economic story.

The natural-gas pipe-line company contracted to supply this gas to the municipal plant for a trial period of one year, the pipe-line company bearing all expense for the change-over in furnace and firing equipment necessary to install natural gas as a fuel on one of the boilers of the light plant.

The firm of Burns & McDonald of Kansas City was retained by the public utility board of Rochester to study this question for the city. They reported that a small saving in fuel cost would be possible with natural gas at 22c. per 1,000 cu.ft., and an equal cost possible at 23c. They recommended against any rate which included the turning over by the city to the gas company of any part of the savings in production cost resulting from the use of natural gas fuel due to the complications which might arise from such a rate feature.

The final decision of the public utility board was to try gas in the plant for a period of one year and a contract was signed calling for a flat rate of 22c. per 1,000 cubic feet.

At the end of a year's trial the city has the option to renew the contract at the same rate for four more years. In this event the city will reimburse the gas company for the expense of all this equipment and its installation. Comparative tests between coal fired on an underfeed stoker and natural gas are contemplated by the management of the Rochester plant during this year.

### Plant Modernization Pays

A further paper given at this session was devoted to the discussion of some twenty power plants reconditioned and modernized to use Midwest coals. The results obtained showed returns on the investment in new equipment ranging from 15 per cent to 35 per cent per year, and were obtained principally by the modernizing of the plant so as to utilize the cheaper types of Midwest coals together with the replacing in some cases of higher-priced, low volatile, low-ash, Eastern bituminous coals. Further improvements were shown by the checking of careless and inefficient operating conditions and methods within the plant.

At an informal dinner session Thursday night, M. M. Leighton, chief of the Illinois State Geological Survey described the results of research studies on Illinois coal carried on in the Urbana laboratories. Dean A. A. Potter of Purdue and Dean M. S. Ketchum of the University of Illinois both spoke on the value of coal research and on the contributions of educational institutions to industry.

Mathew Harriman, president of the Indiana Branch of the National Association of Power Engineers, gave a brief talk and introduced the various state officers of the organization. Fred Raven, national secretary of the organization also spoke at this dinner.

The stoker session held Friday afternoon and presided over by B. R. Gebhart, director of public relations of the Illinois Coal Bureau, was principally a discussion tending to clarify some of the points of difference between the coal trade and the stoker manufacturers. The necessity for these two combining so as to successfully combat the spreading use of competitive fuels was the keynote of this session.

One point brought out was the necessity for basic design changes in small stokers, so that they might burn, more successfully, coals having fusion temperatures under 2,300 deg. F. and of medium ash content. Such improvement would not only increase the variety of coals that existing stokers could handle successfully, but would result in improved operation with the higher grade fuels.

## P.E.A. Hydraulic Committee Holds Spring Meeting

On April 21 and 22, the hydraulic power committee of the Pennsylvania Electric Association held its spring meeting in Lancaster, Pa., with headquarters at the Stevens Hotel. This meeting proved to be one of the most successful in the history of the committee, both in value of the papers presented and in attendance. About 75 members and their guests attended. The three technical sessions were presided over by M. J. McCleary and C. B. Seib, the retiring and incoming chairman, respectively.

The technical session on Thursday was held at the Holtwood plant of the Pennsylvania Water & Power Company. E. S. Loane opened the session with a report on the last meeting of the N.E.L.A. national hydraulic power committee. Two features of the report of this committee are a paper on cavitation by Professor W. Spannhake, and a paper by Professor C. G. Fink, on paint for protecting under-water surfaces. This report is now in the hands of the printer and should be available in the near future.

Experiences in operating the Saluda hydro-electric plant of the Lexington Water Power Company, near Columbia, S. C., were given by O. L. Hooper. In this plant there are four 55,650-hp. units, two of which have a surge tank on their penstocks and two have not. Sensitive governors control the units equipped with surge tanks and take the

load swings. The two units without surge tanks have slow-acting governors and carry base loads.

Surges in streams, reservoirs and lakes was the subject of a talk by J. E. Stewart. Last year the hydraulic committee initiated a study of ground-water levels and their relation to runoff. Since then 35 wells have been put under observation in Pennsylvania, some of them with water-lever recorders. This work is being done in cooperation with the United States Geological Survey and other interested agencies and was reviewed by H. W. Lowy in a paper on "Ground Water Supply."

A subcommittee of the hydraulic committee has been working on the problem of producing a standard schedule of inspection and maintenance for hydroelectric plants. A progress report of the subcommittee's work was presented by C. E. MacMurray.

### Pitting Remedies Discussed

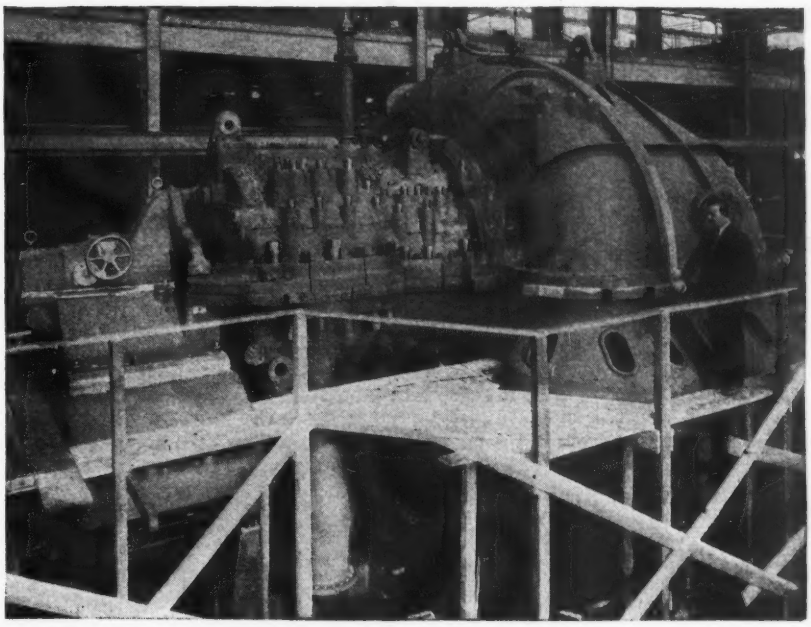
George Diehl presented a very interesting paper on the safety and accident-prevention features that have been incorporated in hydraulic maintenance work at the Holtwood plant. This was followed by a talk by T. C. Stabley on how pitting of water wheels has been combatted at the same plant. Various means have been tried, such as metal spraying, welding, the application of rubber to pitted areas and paint. Good results were reported from applying stainless steel by welding.

After the technical session, the committee members and their guests were given an opportunity to inspect the Holtwood plant and the company's cavitation laboratory. In this laboratory extensive researches are being made on cavitation in connection with the design and operation of the Kaplan wheels being installed in the Safe Harbor plant, about eight miles above Holtwood.

Friday morning was devoted to an inspection of the Safe Harbor plant of the Safe Harbor Water Power Corporation. This plant is designed for an ultimate capacity of 510,000 hp. in twelve 42,500-hp. Kaplan turbines to operate under a 55-ft. head. These are the largest wheels of this type that have ever been built, and four of them are now in operation. A story of this plant appeared in the March 15 number of *Power*.

At the Friday afternoon session, A. A. Meyer, presented a paper on the "Design of Safe Harbor Plant," and P. M. Hess told of how the plant was put into operation and how the operating personnel was organized and trained. A paper on governors, by Albert Kalin, presented by William Bolan, described several installations, their operating features being demonstrated by motion pictures. The meeting was closed by a very comprehensive talk on cavitation of waterwheels by C. E. Merriam, in which he reviewed the work done by Dr. D. Thoma, and Professor W. Spannhake, and explained the theory of how cavitation is produced.

## NEW 75,000-KW. UNIT FOR KEARNY PLANT



**The 75,000-kw., 1,800-r.p.m. turbine-generator to be installed at unit No.6 at the Kearny station of the Public Service Electric & Gas Company of New Jersey, is shown on test at the Westinghouse plant in South Philadelphia. Operating at 350 lb. pressure and 750 deg. F. total temperature, the new unit will receive part of its steam from the mercury-vapor condensers serving the 20,000-kw. mercury unit also being installed. The major portion of the steam supplied the 75,000-kw. turbine, however, will come from the existing boiler equipment at the Kearny station**

▼ ▼ ▼

## A.S.M.E. Adopts Standard for Hydro Turbine Shaft Couplings

A DIMENSIONAL STANDARD for integrally forged flange-type shaft couplings for hydro-electric turbine-generator installations has been approved by the American Society of Mechanical Engineers Standardization Committee and adopted as an A.S.M.E. Standard by unanimous vote of the society's council. It is now before the American Standards Association for approval and designation as an American Standard.

This standard gives detailed dimensions of the couplings, drilling layout and bolt dimensions, together with tolerances for the mating parts and such other necessary information to permit complete interchangeability. The shaft diameters covered range from 3½ to 40 in., increasing by ½-in. intervals up to 9 in., and by 1-in. intervals from 9 to 40 inches.

The design and dimensions as set forth were developed by a committee consisting or representatives of the six largest manufacturers of hydraulic turbines and electric generators. This committee was appointed by the A.S.M.E. Hydraulic Division, an action prompted by a recommendation received in May, 1928, and was organized in December of the same year.

In December, 1929, the committee's recommendations were presented to the A.S.M.E. Hydraulic Division and since that date the design and dimensions proposed have been generally accepted by both American and Canadian manufacturers of generators and hydraulic turbines.

## Work Rushed on Madden Dam Development in Panama

CONSTRUCTION of the Madden Dam water supply and power project in Panama is being rushed, with 650 men working day and night, according to press dispatches of April 23. Progress made by the two firms handling the $15,500,000 project—Callahan Company and Shirley, Peterson & Gunther—has astonished critics who at first thought that their bid of $1,000,000 less than it had been estimated the work would cost would result in failure to fulfill the contract.

At the present rate of progress, experts believe, the dam will be completed well within the time limit in November, 1934. The contractors are completing the elaborate steel structures required for pouring 520,000 cu.yd. of concrete for the main dam. Ten dirt saddle dams have been finished, and workers are clearing the forest and undergrowth from the 1,500-acre reservoir area. Work of pouring 2,000 cu.yd. of concrete daily will begin in a few days. The workers are employed in eight-hour shifts.

## Power Commission to Investigate Florida Rates

THE Federal Power Commission has issued an order addressed to its licensees in Florida by which the commission enters upon an inquiry into the services, rates and charges by these licensed companies or their customers engaged in public service. This action is taken by the commission on its own motion without formal pleading, although informal complaint has been made by a citizen of Florida through his congressman.

The commission also declared its intention to exercise its jurisdiction over the control of the securities hereafter to be issued by these licensees in Florida. The federal water power act confers this authority over services, rates and charges, and securities by reason of the fact that Florida, unlike most of its neighbor states, has no state commission or other agency with such authority.

The commission's order will be served on the Ocklawaha Reclamation Farms and the West Florida Power Company, the two licensees in Florida, ordering filing of schedules and tariffs on or before 30 days of such notice.

## Patent Exhibit Opens in New York City Next Week

THE FOURTH International Patent Exposition will be held at Grand Central Palace, New York City, from May 10 to 28. Its purpose is to bring inventors and inventions in contact with manufacturers. The honorary chairman is Major-General George O. Squier, noted inventor and formerly head of the Air Forces, United States Army. Further information may be obtained from Herman Larson, managing director, Grand Central Palace, New York City.

## Seattle Votes Bond Issue for Completion of Diablo Plant

COMPLETION of the hydro-electric generating plant at Diablo, the construction of a transmission line between the Diablo and Gorge Creek stations, and completion of other work in the Skagit development is provided for in a bill passed April 19 by the Seattle City Council and immediately approved by Mayor Robert H. Harlin.

A resolution was adopted directing the city comptroller to offer for sale $3,500,000 light and power bonds to cover the cost of this improvement and to pay the outstanding warrants issued for Skagit improvements. The date of May 18 has been fixed for the opening of bids for the bonds, and at the same time the board of public works will receive bids for the extension work, payment to be made in bonds or cash. If the bonds bring a reasonable offer, they will be sold outright. The successful bidder must not only accept bonds in payment for his work, but he must take additional bonds in amount sufficient to pay the $1,400,000 present indebtedness on the plant.

If satisfactory bids for the bonds are not received, the board of public works will be directed by the council to accept the low bid for the contract to complete the Diablo work, under the ordinance passed.

Efforts will be made to bring out offers to rival the recent proposal of the Bayly Hipkins Company. This company offered to furnish the cash to settle the light department's contracts, largely for machinery and power cable, on condition that the company be given the new construction work at a stipulated price. The company was to accept the city light bonds yielding 6 per cent interest in return.

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## COMING CONVENTIONS

**American Society of Mechanical Engineers.** Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Management, Maintenance and Materials Handling Congress at the Hotel Statler, Detroit, Mich., May 4-5. Oil and Gas Power meeting at Pennsylvania State College, June 8-11. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

**American Institute of Electrical Engineers.** District meeting at Providence, R. I., May 4-7. Annual summer convention at Cleveland, Ohio, June 20-24. Heaquarters, 33 West 39th St., New York.

**American Boiler Manufacturers Association.** Annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. Secretary, A. C. Baker, 801 Rockfeller Building, Cleveland, Ohio.

**American Society of Heating and Ventilating Engineers.** Semi-annual meeting at the Hotel Pfister, Milwaukee, Wis., June 27-29. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

**American Refractories Institute.** Annual spring meeting at the Wm. Penn Hotel, Pittsburgh, Pa., May 18. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

**American Society for Testing Materials.** Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

**Association of Iron and Steel Electrical Engineers.** Annual convention in Pittsburgh, Pa., June 20-24. Managing Director, John F. Kelly, Empire Building, Pittsburgh.

**National District Heating Association.** Annual convention at the William Penn Hotel, Pittsburgh, Pa., June 14-17. Secretary, D. L. Gaskill, Greenville, Ohio.

**National Electric Light Association.** Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

**Universal Craftsmen Council of Engineers.** Annual convention at Cedar Point, Ohio, Aug. 2. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

## Diesel Ship Makes Long Continuous Run

THE M. S. DAYLIGHT, powered by a Sun Doxford 3,256-hp. 2-cycle, 4-cylinder solid-injection diesel engine, recently completed a 30,000-mile voyage without a stop for engine repairs, and at the end of this trip the cargo was discharged and the vessel immediately proceeded on another voyage. During the 30,000-mile trip the main engine was in operation 123 days, 12 hr. and 58 min. The vessel, a tanker owned by the Standard Vacuum Transportation Company, proceeded from New York to Beaumont, Tex., where it took on a full cargo and sailed for Bombay, India, via Cape Good Hope, a continuous run of 51 days, 10 hr. and 40 min. The return trip was from Karachie, India, via Pacific Route to San Pedro, Calif., a run of 43 days, 8 hr., 52 min., and from San Pedro to New York, 20 days, 2 hr. and 30 minutes.

Average speed for the whole trip was 10½ knots, which was the pre-arranged speed for the voyage. The actual fuel consumption of the main engine was 0.31 lb. per indicated horsepower per hour, the crankcase lubricating oil used was 0.0000255 gal. per indicated horsepower per hour and the cylinder lubricating oil 0.000102 gal. per indicated horsepower per hour.

## Industry's Attitude to Trade Shows Reported

A SPECIAL REPORT covering the consensus of opinions of leading manufacturers in twelve industrial groups relative to exhibiting in 82 trade and association shows scheduled for 1932-1933 has just been issued by the Exhibitors Committee Industrial and Power Shows, Inc., 420 Lexington Ave., New York City.

The report is based on the replies to a questionnaire received from 600 manufacturer exhibitors, divided into the following general groups: Operating equipment and supplies; electrical equipment; heating and ventilating; machines, welding, refrigeration equipment and safety devices; instruments and accessories; piping, valves and fittings; water conditioning and circulation; steam, gas and air; fuel and ash; refractories and insulation; miscellaneous equipment and service products; technical press and educational.

Although more than half of the questionnaires sent out were unanswered, the majority of the replies received were with few exceptions unfavorable to exhibiting in any of the 82 shows. Notable among the exceptions were the New York Power Show, at which a majority of manufacturers in every group were in favor of exhibiting, and the Chicago Power Show, which was favored by a majority in seven of the groups.

# Personals

FRANK L. DAME was elected chairman of the board, and EDWIN GRUHL, president of the North American Company, New York City, at the directors meeting on April 25. Mr. Dame has been president of the company since 1921, and prior to that he supervised utility operations of companies formerly controlled by the General Electric Company in various parts of the United States. Mr. Gruhl, who joined the North American Company in 1912 and has been vice-president and general manager since 1921, was formerly in charge of the research and statistical department of the Wisconsin Railroad Commission.

JOHN E. ZIMMERMANN, president of the United Gas Improvement Company and chairman of the board of the Philadelphia Electric Company, has been elected a director of the Pennsylvania Railroad Company to succeed Charles E. Ingersoll, resigned.

JOSEPH JAMES PICKETT, mechanical and electrical engineer, formerly vice-president and operating manager of the East Coast Utilities Company, Chicago, has been appointed senior assistant utilities engineer of the Maryland Public Service Commission, with headquarters in Baltimore. Mr. Pickett's previous connections include the Aluminum Company of America, Pittsburgh; Lee C. Moore Company, also of Pittsburgh; Sanderson & Porter, Chicago consulting engineers; and Hagenah & Erickson, also consulting engineers of Chicago.

C. O. VON DANNENBERG, formerly assistant engineer with the Electric Management & Engineering Corporation, New York City, has recently joined the engineering department of the Pennsylvania Central Light & Power Company, Altoona, Pa.

MORGAN J. HAMMERS, vice-president and general manager of the Petroleum Heat and Power Company, New York City, was elected president of the American Oil Burner Association at its recent annual meeting in Boston, Mass.

E. W. MORRIS, formerly identified with the Los Angeles office of the Westinghouse Electric & Manufacturing Company in the capacity of general engineer, is now with the San Francisco office of the company in the capacity of industrial applications engineer.

HOMER W. CLARK, secretary of the engineering firm of Hubbell, Hargering & Roth, has been appointed a member of the Detroit water board, succeeding ALEX DOW, president, Detroit Edison Company, who has resigned after serving as the engineering member and president since 1916.

## How's Business?

DESPITE the doubts and discouragements about certain fundamental features of the situation, particularly as regards official and legislative attitudes toward the problem of recovery, April afforded some evidence of inherent economic vitality and convalescence, according to *The Business Week*, May 4. The decline in important business indicators and in commodity prices slackened and in some cases ceased. Merchandise carloadings have risen moderately, and as the month closes steel production is slowly expanding under the stimulus of increasing activity in the automobile industry, which is expected to continue for several months. More significant are the first signs that Federal Reserve efforts to start credit expansion are beginning to take effect.

Public utility power production for the week ended April 23 was 1,469,810,000 kw.-hr., 12.3 per cent under that for the corresponding period of 1931, the N.E.L.A. reports.

# Business Notes

HAGAN CORPORATION, Pittsburgh, Pa., announces that E. W. Wagenseil has been added to the Pittsburgh sales engineering department. For the past five years Mr. Wagenseil has been in charge of air preheaters sales for the Blaw-Knox Company, and prior to that was engaged in stoker engineering and sales for the Westinghouse company and the former Harrington Stoker Company.

STANDARD OIL COMPANY OF INDIANA in publishing each month a technical monograph on the lubrication of some type of equipment. The series, which started last month, will go through the whole line of the more important industrial equipment, giving specific, authoritative information on the proper lubrication for each type of machinery. No recommendations for any particular brand of lubricant will be made, the company states. Requests for these monographs should be addressed to the technical division, 910 South Michigan Ave., Chicago, Ill.

MORRIS MACHINE WORKS, Baldwinsville, N. Y., announces that its export office is now located at 30 Church St., New York City. The cable address of the new office is "Brosites."

PITTSBURGH EQUITABLE METER COMPANY, Pittsburgh, Pa., has completed arrangements for acquiring all of the capital stock of the MERCO NORDSTROM VALVE COMPANY, San Francisco, Calif., and the latter will henceforth operate as a division of the former. W. F. Rockwell of the Pittsburgh company becomes president of the Merco company. Warehouse stocks for both companies will be carried in Los Angeles, Kansas City, Chicago, Columbia and certain other points; sales offices of each will be available to the other. It is the intention of the enlarged organization to add new products and accessories to the present lines.

RELIANCE ELECTRIC & ENGINEERING COMPANY, Cleveland, Ohio, has established a sales branch in Grand Rapids, Mich., located at 208 Fuller Ave., S. E. Marshall T. Ball, will be in charge of the new office.

# Trade Catalogs

PIPES AND TUBES—A new bulletin devoted to stainless and heat-resisting pipe and tubes has been published by the National Tube Company, Frick Building, Pittsburgh, Pa. Properties of the alloys used in the tubular products, fabrication and applications are comprehensively covered. Tables of weights and dimensions and of resistance to common chemicals are included, together with many illustrations of actual installations.

AIR CONDITIONING—B. F. Sturtevant Company, Hyde Park, Boston, Mass., has published a new catalog, No. 388, describing its system of air conditioning for railway passenger cars. Mechanical and ice-storage cooling apparatus are shown, together with the ductless method of air distribution for both methods of cooling. Another new catalog, No. 387, of the company covers tools and attachments for use with Sturtevant portable and stationary vacuum cleaners.

• RESISTANCE MEASUREMENTS — An illustrated description of a full line of instruments for electrical resistance measurements is contained in Catalog 40 recently issued by the Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa. The apparatus includes standard resistors, resistance boxes, Wheatstone bridges, calibrated slidewires, Kelvin bridges, galvanometers and insulation resistance sets.

OPTICAL PYROMETER—Features of the Bacharach H-K optical pyrometer are fully described and illustrated in Bulletin 296 just issued by the Bacharach Industrial Instrument Company, 7000 Bennett St., Pittsburgh, Pa. The bulletin also contains useful information on the method of operation of the pyrometer and the conditions for correct readings.

SPEED REDUCERS—Bulletin No. T-111 just issued by the Murray Iron Works Company, Burlington, Ia., describes and illustrates the company's high-speed herringbone reduction gears for turbine, motor or oil-engine drives.

# NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

**Calif., Oakdale**—Oakdale Irrigation District, plans construction of a waterworks pumping plant to furnish water for irrigation of 200 acres of land in vicinity of Lone Creek.

**Ill., Springfield**—City is completing plans for improvements to power plant including condenser and boiler, etc. Estimated cost $155,000. Burns & McDonnell Engineering Co., 406 Interstate Bldg., Kansas City, Mo., is engineer.

**Ind., Fort Wayne**—Board of Public Works, S. S. Snyder, Secy., will receive bids until May 10 for construction of a boiler room. Estimated cost $200,000. Private plans.

**Ia., Des Moines**—Veterans Administration, 764 Arlington Bldg., Washington, D. C., will receive bids until May 31 for Veterans hospital including refrigerating and ice-making plant, etc., here. Estimated cost $1,100,000. Private plans.

**Ia., Grand Junction**—Town plans new election May 12 to vote on question whether Town will establish, erect, extend, maintain and operate within or without its corporate limits an electric light and power plant including two 265 or 240 hp. Diesel engines, two 185 kw. or two 170 kw. electric generators direct connected to Diesel engines, and complete distribution system. $85,000. G. J. Long, Webster City, is engineer.

**Ia., Ottumwa**—John Morrell & Co., awarded contract for construction of a 7 story cooling and storage building to T. Slack Co., 118 South 11th St., West Cedar Rapids. Estimated cost $300,000.

**Mass., Medfield** — Commonwealth of Massachusetts, Department of Mental Diseases, State House, will receive bids until May 10 for construction of a pumping station including equipment at State Hospital. J. J. Valkenburgh, Framingham, is engineer.

**Nev., Boulder City** — Boulder City Builders Supply Co., has secured permit from Bureau of Reclamation to construct ice plant.

**N. J., Clifton**—Forstmann & Huffman Co., 2 Barbour Ave., Passaic, will build two 1 story boiler house plants at Lake and Randall Aves. here. Estimated cost $40,000. M. Heiser, 2 Barbour Ave., Passaic, is architect and engineer. Work will be done by separate contracts.

**N. Y., Bedford Hills**—Department of Correction, State Office Bldg., Albany, will receive bids until May 17 for refrigeration work, storehouse, dining and kitchen building at State Prison for Women, Westfield State Farm here.

**N. Y., Creedmoor** — Department of Mental Hygiene, State Office Bldg., Albany, awarded contract for heating and power plant equipment at Brooklyn State Hospital, to A. D. Granger Co., 15 Park Row, New York. $64,888.

**N. Y., New York**—Commission of Immigration, Ellis Island, awarded contract for conversion of power plant for use of fuel oil to R. H. Baker Co., 405 Lexington Ave., New York, N. Y. $24,900.

**N. Y., New York**—Rubel Corp., Fulton St. and Waverly Pl., Brooklyn, awarded contract for a 2 story, 66 x 97 ft. addition to ice manufacturing plant at St. Anns Ave. and 159th St., to Gustav Jensen, 8124 11th Ave., Brooklyn.

**N. Y., New York**—Springler Electric Corp., c/o Smith, Chambers & Clare, Attys., 60 Broadway, has made application to Public Service Commission for permit to construct electric power plant and distribution system to serve area 13th-15th Sts., Union Square and University Place W. to Fifth Ave.

**N. Y., Wellsville** — Elmira Water, Light & Railroad Co., Elmira, has been authorized by Public Service Commission to construct power plant and electric distribution system here. Estimated cost to exceed $40,000.

**O., Norwalk** — City will receive bids until May 7 for construction of sewage treatment plant including pump house, laboratory building, etc. Estimated cost $400,000. G. E. Scott, City Hall, is city engineer. H. P. Jones Co., Second National Bldg., Toledo, is consulting engineer.

**Okla., Idabel**—City is having preliminary plans prepared for construction of a municipal electric light plant. Estimated cost $100,000. F. D. Taffe, Idabel, is engineer.

**Va., Langley Field** — Construction Division, War Dept., awarded contract for transformer vaults, house and underground electric distribution system for street lighting circuit to L. E. Myers Construction Co., 84 William St., New York. $96,132.

**Wash., Seattle**—Board of Public Works, will receive bids about May 13 for 65 x 230 ft. superstructure on existing foundations for Diablo power house; power house tail race complete; assembly and erection of power house machinery including two 67,500 kva. hydroelectric generating units, step-up transformer and auxiliary equipment; furnishing and installing switchboards, control wiring, switches, switchstructures and other equipment; constructing 220 kv. double circuit steel tower line, 5.75 miles in length from Diablo plant to connect with existing Gorge transmission line including 19 towers, etc., constructing protecting apron for north spillway of Diablo dam.

**Mexico, Juarez**—City of Juarez, having preliminary surveys made for construction of a municipal power plant to supply power for lighting system and waterworks pumping, etc. Private plans.

**United Soviet Socialist Russia**—Commissariat for Agriculture, c/o Amtorg Trading Corp., 261 5th Ave., New York, N. Y., appropriated $17,000,000 for electrification during 1932 including construction of thirty-one power stations, ninety-five sub-stations and 20,000 windmills to generate power for farms.

## Equipment Wanted

**Boilers — Boston, Mass.** — Metropolitan District Commission, 20 Somerset St., will receive bids until May 12 for four vertical tube boilers, 98 in. in diameter and 24 ft. high for working steam pressure of 185 lb. per sq.inch.

**Boilers—Del Rio, Tex.**—Treasury Department, Office of Supervising Architect, Washington, D. C., will receive bids until May 16 for new heating boilers here.

**Boilers—Fort Logan, Utah**—Quartermaster, will receive bids until May 9 for ten cast iron jacketed steam boilers, 800 and 1,050 sq.ft. Cir. 40.

**Boilers, Electrical Equipment, Etc.—Ludington, Mich.**—City plans to purchase new boilers, electrical equipment and Diesel engines, etc., in connection with waterworks and distribution systems. Estimated cost $25,000.

**Electrical Control Apparatus—Joliet, Ill.**—D. I. Sultan, Lt. Col. Corps of Engineers, First District, 333 North Michigan Ave., Chicago, Ill., will receive bids until May 18 for electric control apparatus for Brandon Road Lock on Des Plaines River, including electrical equipment, power, lock signals, etc.

**Engine—Philadelphia, Pa.**—Bureau of Supplies & Accounts, Navy Department, Washington, D. C., will receive bids until May 10 for gasoline motor driven fire engine for Navy Yard here. Sch. 7930.

**Engine and Pump—Oshkosh, Wis.**—Lake View Memorial Park, plans to purchase gasoline engine and centrifugal pump for well and pump pits.

**Generator Sets, Pumps, Condenser, Etc.—New York and San Francisco**—Bureau of Supplies & Accounts, Navy Deptartment, Washington, D. C., will receive bids until May 17 for turbine generator sets, accessories and spares also pumps, dynamo condenser, circulating and condensate and spare parts for Navy Yards here. Schs. 7924 and 7934.

**Motors—Jeanerette, La.**—Division of purchase, Sales & Traffic, Department of Agriculture, Washington, D. C., will receive bids until May 10 for one 5 and one 15 hp. electric motors here. Pro. 1615.

**Motors, Transformers, Switches, Etc.**—Washington, D. C., General Purchasing Officer, Panama Canal, will receive bids until May 18 for electric motors, transformers, switches, etc. Sch. 2750.

**Pumps—Puget Sound, Wash.**—Bureau of Supplies & Accounts, Washington, D. C., will receive bids until May 17 for circulating pumps for main motors and spares. Sch. 7836.

**Regulators—Mare Island (Sta. Vallejo) Calif.**—Bureau of Supplies & Accounts, Navy Department, Washington, D. C., will receive bids until May 17 for four feed water regulators and spares also boiler water level recorders. Sch. 7932.

**Regulators—Capetown, South Africa**—Superintendent of Municipal Electrical Department, will receive bids until June 22 for supply of voltage regulators for use in three ph. 50 cycle circuits of 4 wire 398/230 v. system.

**Water Wheel, Turbine and Undershot — Tampico, Tamps, Mexico**—R. G. Piper, Apartado, 844 Tampico, Tamps, interested in prices and data on small water wheel, turbine and undershot.

## Industrial Projects

**Calif., Avon** — Associated Oil Co., 79 New Montgomery St., San Francisco, awarded contract for construction of a lubricating oil plant here to Foster-Wheeler Corp., 165 Broadway, New York, N. Y. Estimated cost to exceed $250,000.

**Calif., Fresno** — California Raisin Products Corp., leased old Fresno brewery and will remodel and install electric refrigeration plant and bottling machinery.

**Ia., Council Bluffs**—Bouricious Battery Co., G. Bouricious, Pres., plans to rebuild battery plant destroyed by fire. New equipment will be installed.

**Mass., Malden** — Barrett Co., 40 Rector St., New York, N. Y., acquired site and plans construction of a tar and roofing products manufacturing plant and storage building here. Estimated cost $100,000.

**Mich., Midland**—Pure Oil Co., awarded contract for design and construction of a new oil refinery to Alco Products Co., 220 East 42nd St., New York, N. Y. Estimated cost to exceed $350,000.

**N. J., Newark**—J. J. Hoehenjos Co., 829 Broad St., will soon award contract for construction of a 3 story paint manufacturing plant on Frelinghuysen Ave. Estimated cost $40,000. Henry D. Scudder, Jr., 9 Clinton St., is architect.

**Pa., Grove City**—Wendell August Forge Inc., E. J. Fithian, Pres., has work under way on construction of a 1 story plant for the manufacture of aluminum forged work on Madison Ave. $40,000. Work under owner's supervision.

**S. D., Sioux Falls**—General Manganese Co., 155 Van Congress St., Detroit, Mich., plans construction of first unit of refinery here. Estimated cost $200,000.

**Tex., Houston**—Continental Can Co., 1 Pershing Sq., New York, will receive bids after July 1 for construction of a can manufacturing plant here. Estimated cost $100,000. Favrot & Livaudais, Hibernia Bldg., New Orleans, La., are architects.

**Tex., McAllen**—Valley Refining Co., c/o W. K. Campbell, will build a refinery near here, capacity 500 bbl. of crude oil and 100 bbl. of lubricating oil. Plans include installation of a skimming and blending unit, later will add a cracking unit. Estimated cost $40,000. Work will be done by owner's forces.

**Wis., Eau Claire**—National Pressure Cooker Co., 1515 Ball St., manufacturers of canning apparatus, awarded contract for a 1 story, 50 x 100 ft. addition to factory to Olson & Walker, 304½ North Barstow St.

**Wis., Wausau**—Underwood Veneer Co., O. C. Lemke, Mgr., Thomas St., plans to rebuild plant destroyed by fire. Architect not selected.

**Alta., Coutts**—Northwest Stellarence Co., will soon award contract for reconstruction and alterations to refinery including equipment. Estimated cost $150,000.

**Ont., Windsor**—A. S. Boyle Co., 907 Elliott St., manufacturers of drug specialties, having plans prepared for construction of a 4 story, 60 x 140 ft. factory including 2 story, 25 x 70 ft. boiler house. Estimated cost $150,000. Pennington & Boyde, Security Bldg., are architects.

**South America, Colombia**—Imperial Oil Co. Ltd., 56 Church St., Toronto, Ont., subsidiary of Standard Oil Co. of New Jersey, 26 Broadway, New York, N. Y., plans construction of a large refinery in vicinity of Cartagena here. Estimated cost to exceed $1,000,000. Maturity indefinite. Project is dependent upon tariffs and restrictions on oil importations into United States.

**United Soviet Socialist Russia**—c/o Amtorg Trading Corp., 261 5th Ave., New York, N. Y., will build a can manufacturing 62 million cans annual capacity in Slaviansk (North Caucasus), also ship building plant 90 dredges and 150 tugs annual output at Perm (Ural Region). Approximately $33,000,000. Work for both plants will be done by day labor and technical aid contracts.